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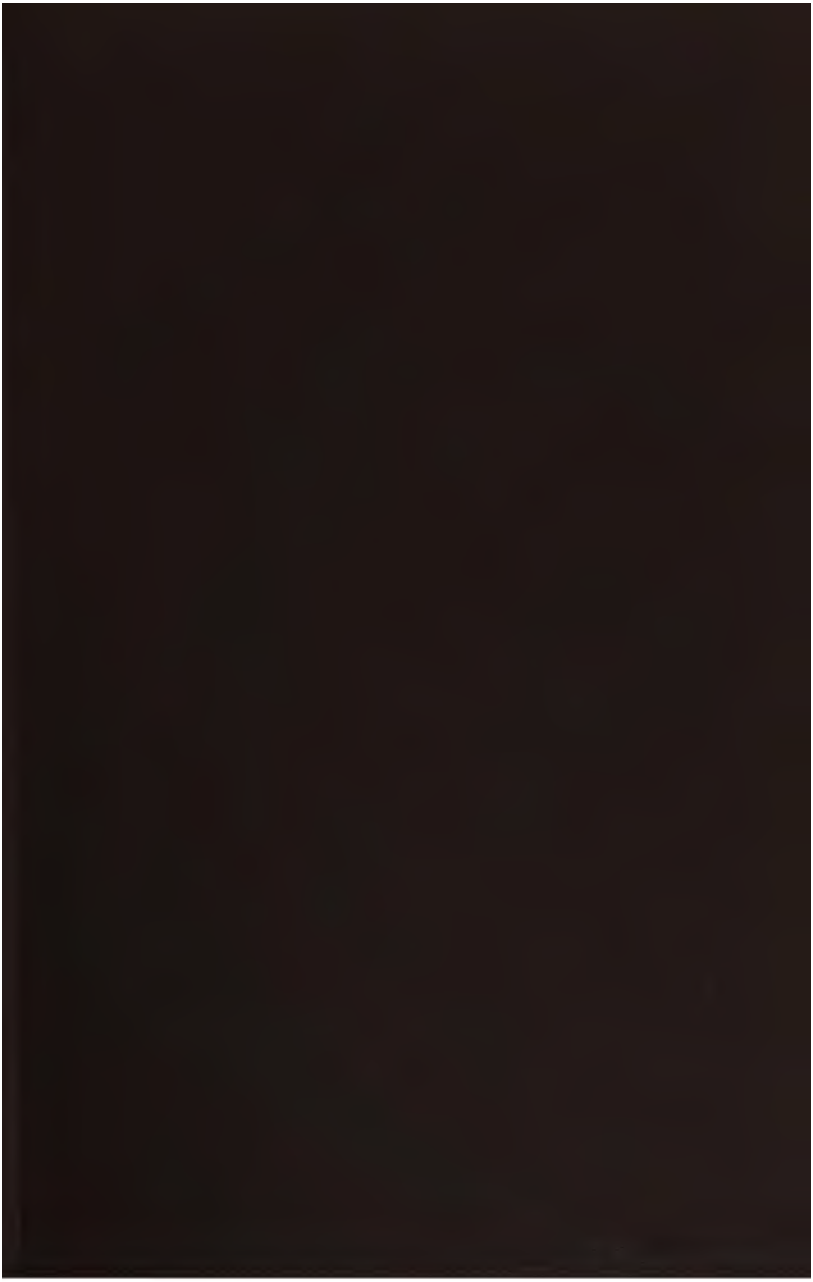

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Enlarged view of the left Membrana tympani
as seen through the speculum

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HANDBOOK

OF

DISEASES OF THE EAR

FOR THE USE OF

STUDENTS AND PRACTITIONERS

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BY

URBAN PRITCHARD, M.D. (EDIN.), F.R.C.S. (ENG.)

PROFESSOR OF AURAL SURGERY AT KING'S COLLEGE, LONDON;
AURAL SURGEON TO KING'S COLLEGE HOSPITAL;
SENIOR SURGEON TO THE ROYAL EAR HOSPITAL

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PREFACE TO THE THIRD EDITION.

In preparing a third edition of this work for the press, the whole has been carefully revised, a large portion re-written, and upwards of thirty pages of new matter added; this has necessitated a certain amount of re-arrangement, but at the same time I have endeavoured to preserve the original character of the work.

The great strides that have been made of late years in the diagnosis and operative treatment of mastoid troubles and intra-cranial suppuration, have induced me to re-write and considerably amplify this portion of the work, and I have, therefore, gone into details as minutely as the character of this short handbook would permit.

Of the other alterations the most important are:—

1. The section dealing with the chief methods of operating for the removal of adenoid vegetations in the naso-pharynx, has been considerably elaborated.

2. The operation for removal of the ossicles is described and commented upon.

3. The condition known as Cholesteatoma has been separately dealt with.

4. A brief sketch of disease of the bony capsule of the labyrinth (Politzer) has been given.

A few of the illustrations have been changed and four new ones added, including among the latter a section shewing the fibrous bands fixing the stapes to the walls of the bony pit in which it is situated.

For much valuable advice in carrying out this revision, and especially upon every point connected with the administration of anæsthetics, I am again indebted to my friend and colleague, Dr. Frederick Silk, whom I also have to thank for his assistance in passing these sheets through the press.

URBAN PRITCHARD.

26 Wimpole Street, London, W.
June, 1896.

PREFACE TO THE FIRST EDITION.

My object in writing this Handbook has been, not to give an exhaustive treatise on Otology, or even a digest of the many excellent works which are already published, but to present to my readers a practical manual which shall help them to recognise the various pathological lesions of the ear, to diagnose the different diseases, and to discriminate in the matters of treatment and prognosis.

As far as possible I have endeavoured to avoid controversial points and to give simply the results of my own observation and practice. In thus, to a certain extent, limiting the subject, I have been compelled to pass by somewhat cursorily those operative modes of treatment which have proved less successful in my hands, although I am well aware that some of them are advocated by distinguished aural surgeons for whose opinions I have the greatest respect.

In the preparation of this Handbook I have received much kindly assistance from several of my confrères, to

whom I desire here to tender my hearty thanks; and among these I should like especially to acknowledge my gratitude to Mr. Cresswell Baber for his many thoughtful and valuable suggestions, to Professor Burckhardt-Merian for the original drawing from one of his Eustachian tube preparations, and to Mr. Arthur Kinsey for help in the chapter on the Education of Deaf-mutes.

URBAN PRITCHARD.

July, 1886.

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DISEASES OF THE EAR.

INTRODUCTION

THE auditory apparatus is concerned with two entirely distinct functions, *hearing* and *equilibration;* and disease or lesion of any of its parts will affect either the one or the other, or both. It is the former, however, which is the more frequently impaired, for the simple reason that almost the whole of the apparatus is devoted to the function of hearing, whereas only a very small portion is taken up with that of equilibration.

The most common symptom of disease of the ear is deafness, partial or complete, or, in other words, *diminution* or *loss* of hearing power; and next to that in frequency is tinnitus (noises in the ear), which may be described as *disturbance* of hearing power.

Before entering into a description of the various forms of disease, it will be necessary to consider briefly the anatomy and physiology of the several parts of this auditory apparatus. It does not come within the scope of this handbook to enter into all minute particulars, and we shall therefore content ourselves with giving a general description only, with especial regard to points of pathological importance; and for a more detailed account would refer our readers to such works as Politzer's *The Human Ear*, translated by Stone, Quain's *Anatomy*, Foster's *Physiology*, Retzius' *Das Gehörorgan der Wirbelthiere*, and Allen's *The Mastoid Operation.*

The human auditory apparatus may be most con-

veniently divided, for our present purpose, into two parts:—

1. *The conducting apparatus.*—Consisting of the external ear (auricle and meatus) and the middle ear (tympanum, Eustachian tube and mastoid process).

2. *The perceptive apparatus.*—This, the essential portion, is made up of the internal ear or labyrinth (containing the nerve endings); the auditory nerve or portio mollis of the 7th cranial nerve (now usually described as the 8th); and the auditory centre, which is that part of the brain from which the nerve takes its origin.

The perceptive apparatus, although the more important part of the whole, would be of but little use without the conducting portion. The nerve endings being bathed in fluid, sound waves passing from the gaseous medium (the atmosphere) to the fluid one (the epilymph), would be almost entirely reflected and lost unless there were some means whereby they might be picked up and transmitted. This duty is performed by the membrana tympani and the chain of ossicles, the essential parts of the conducting apparatus.

Equilibration.—The posterior portion of the internal ear or labyrinth, which comprises the semicircular canals and utricle is, in all probability, devoted to the second and minor function of the organ, equilibration, or the sense of motion and equilibrium.* The nerve fibres of this posterior portion form part of the portio mollis and pass through the cerebellum. Disturbance of any of these parts gives rise to those peculiar phenomena known as auditory vertigo or Ménière's symptoms.

* Some recent researches made by Steiner and Ewald seem to throw a doubt upon the function of the semicircular canals, but their observations have yet to be confirmed.

CHAPTER I.

ANATOMY AND PHYSIOLOGY OF THE EAR.

Conducting Apparatus.

The conducting apparatus, as already stated, consists of:—

1. External ear. Auricle; external meatus.
2. Middle ear. Tympanum and contents; Eustachian tube; antrum and mastoid cells.

For pathological purposes the whole conducting apparatus may be considered as a tube leading from the side of the head to the pharynx, but divided into two *culs-de-sac* by the membrana tympani; the outer one (the external ear) lined with skin, the inner (middle ear) lined with mucous membrane and continuous with the pharynx.

It must be borne in mind that this tube passes through the bones of the skull, and is, in several places, only separated from the cranial cavity by a thin layer of bone; hence the danger of extension of ear disease to the brain.

The External Ear.—The external ear, the outer portion of this tube, consists of the auricle and the external meatus.

The auricle (fig. 1), which may be likened in form to a flattened or crumpled-up funnel, is composed of a skeleton of elastic cartilage covered by skin. The elasticity of this cartilage is an important point, for if the auricle had a bony framework, or even one of hyaline cartilage, it would, from its exposed position, be very liable to

fracture. The skin is closely adherent to the anterior surface of the cartilage, but on its posterior side it is somewhat loosely attached by means of areolar tissue. It will be seen, when we come to discuss the treatment of hæmorrhage and hæmatoma, that this close adherence of the skin to the anterior surface of the cartilage is a point which must be taken into consideration by the surgeon.

FIG. 1.—The Auricle.

a. Helix; *b*. fossa of helix; *c*. anti-helix; *d*. fossa of anti-helix; *e*. tragus; *f*. anti-tragus; *g*. concha leading to the external meatus; *h*. lobe

The lower portion of the auricle (the lobe) is destitute of cartilage, and is made up of areolar tissue and fat between the two layers of cutis. This absence of cartilage makes it possible for the part to be pierced for earrings with impunity, which would not be the case if the perforation had to be made through cartilage.

The skin covering the lobe and the inner surface of the concha is freely supplied with sebaceous glands; these are liable to be converted into sebaceous cysts.

The tragus (the prominence in front of the meatus)

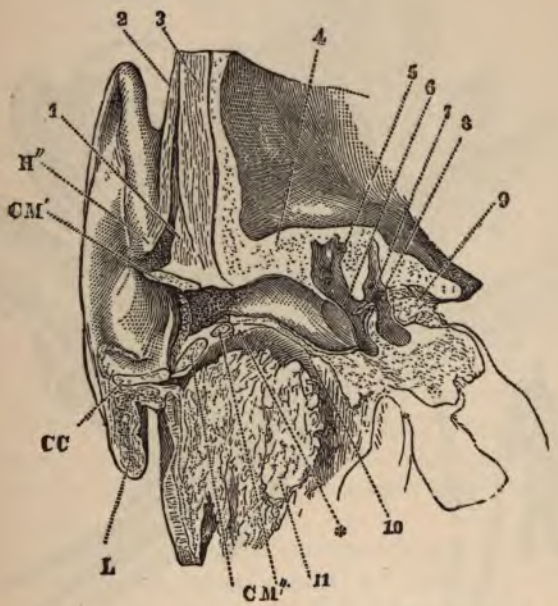

FIG 2.—Section through external meatus, tympanum and internal ear, showing the actual form and relations of the parts (after Henle). CC. Cartilage of auricle. Cartilaginous meatus; CM', roof, CM'', floor. H''. Spine of helix. L. Lobe of auricle. * Fibrous border of osseous meatus. 1. Epicranius temporalis muscle. 2. Levator auricularis. 3. Temporal muscle. 4. Roof of osseous meatus. 5. Cavity of the tympanum. 6. Membrana tympani. 7. Stapes. 8. Vestibule. 9. Internal meatus and acoustic nerve. 10. Floor of osseous meatus. 11. Parotid gland.

is covered on its posterior surface with a tuft of hairs. These hairs occasionally form part of accumulations which obstruct the meatus.

The cartilage of the auricle is continuous with that forming the outer portion of the meatus, and is attached to the temporal bone by fibrous ligaments. There are

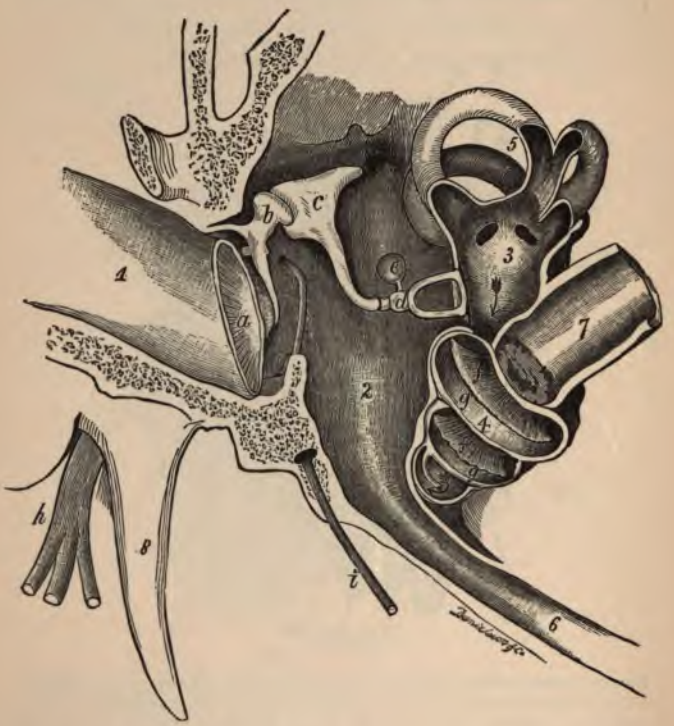

FIG. 3. – A diagrammatic view of the auditory apparatus. 1. External meatus 2. Tympanic cavity. 3. Vestibule. 4. Cochlea. 5. Semi-circular canals. 6 Eustachian tube. 7. Internal meatus for the auditory nerve. 8. Styloid process. *a*. Membrana tympani; *b*. Malleus; *c*. Incus; *d*. Stapes; *e*. Pyramid containing stapedius muscle; *f*. Scala tympani; *g*. Scala vestibuli; *h*. Portio dura; *i*. Chorda tympani.

numerous small ligaments and bands of muscular fibres

connected with the cartilaginous skeleton, but these are of no pathological interest.

External meatus.—The external auditory meatus is a tube leading from the auricle to the membrana tympani, varying slightly in length, but averaging about one inch. The outer third is cartilaginous, the inner two-thirds are osseous. The meatus is curved, and indeed may be said to describe a double curve, so as to be higher in the middle; this curvature is chiefly in the cartilaginous portion and may be straightened by traction of the auricle upwards and backwards. The direction of the meatus is inwards; first a little upwards and backwards, and then forwards and slightly downwards, varying in different individuals. The calibre of the meatus varies somewhat; it is greatest in the cartilaginous portion, diminishes in the first part of the osseous meatus and then enlarges again. The narrowest part, *isthmus*, is about midway in the meatus, and is chiefly due to elevation of the floor; in some cases, especially in patients of a gouty diathesis, this elevation is greatly increased. Foreign bodies are apt to lodge beyond the isthmus, and in consequence may be difficult of removal.

The cartilaginous skeleton of the meatus is continuous with that of the auricle; it has an incomplete tubular form, the tube being completed by fibrous tissue. The floor presents two transverse fissures—fissures of Santorinus—which are filled in with fibrous tissue and serve to give greater mobility to the auricle. This cartilaginous tube is attached to the rough margin of the osseous part by fibrous tissue.

The osseous portion is formed chiefly of a curved plate of bone, the vaginal process, developed from the separate tympanic bone of the fœtus. This curved

plate is not complete at its upper part near the tympanum, the space being filled with fibrous tissue; and this deficiency in the bony wall allows suppurative inflammation to pass between the vaginal and mastoid processes, so as to appear as a superficial mastoid abscess, to be described later on. At the end of the bony meatus is a shallow groove incomplete at its upper part, into which the membrana tympani is inserted. The membrana tympani which divides the meatus from the tympanic cavity is set at an angle of about 55° with the floor, forming a correspondingly obtuse angle with the roof (so that the floor of the meatus is longer than the roof).

The posterior wall of the osseous meatus is perforated by canals for the passage of small veins; these canals run directly backwards into the mastoid cells, and not unfrequently it is through these canals that disease is directly transmitted from the meatus to the cells.

The meatus is lined with skin which gets thinner and thinner as we proceed inwards, and in the osseous portion it is intimately connected with the periosteum. In the cartilaginous portion there are numerous soft hairs and special ceruminous glands which secrete the ear wax; while in the osseous part there are but few hairs, and the ceruminous glands are only found along the posterior and upper wall.

It is important to remember that in the infant the meatus practically consists of only the cartilaginous portion, and is, therefore, quite shallow; the entrance into this infantile meatus is very narrow, and this constriction occasionally persists in the adult. The osseous portion in the infant is merely represented by an incomplete ring of bone (tympanic bone) by the growth or extension of which the osseous meatus of adult life is

formed. This growth or extension does not take place uniformly; in addition to the deficiency in the upper part, alluded to above, there is a narrow cleft along the anterior wall which remains unossified after the rest; gradually however this cleft closes, leaving a foramen. This foramen (Huscke's) is usually filled in by about the third year, but occasionally persists until the fifth year or even to adult life, and may become of pathological importance.

Middle Ear.—The *membrana tympani* divides the meatus from the tympanic cavity. It is not quite circular in form, but slightly oval, with a mean diameter of $\frac{1}{3}$ inch, and resembles gold-beaters' skin both in appearance and thickness. It is inserted at an angle of 55° in the ring-like groove at the end of the meatus, as already stated, and is retracted at its centre so as to be concave; but this is not a regular cup-shaped concavity, for about midway between the retracted centre and the circumference there is a slight convexity.

The membrana tympani, although so very thin, is composed of three layers, the outermost one being cutaneous (modified skin containing no hair follicles) and continuous with the skin of the meatus; the innermost layer is modified mucous membrane with a single layer of tesselated epithelium. Both the cutaneous and mucous layers are well supplied with blood vessels and nerves. The middle layer or membrana propria consists of fibrous tissue. There are two layers of fibres; the outer, the fibres of which radiating from the centre to the circumference, are attached to the tip of the handle of the malleus; and the inner, which consists of circular fibres. The long handle of the malleus is thus embedded in the membrana tympani between its outermost and innermost layers.

At the upper part where the bony groove is deficient, the membrana propria is also wanting, and thus we have a small triangular portion of the membrane that is not so tense as the rest. This is called the *membrana flaccida* or Shrapnell's membrane, and in some extremely rare cases a small foramen is normally found in this position.*

FIG. 4.—Dissection showing the tympanic cavity, the outer wall with membrana tympani having been removed. *a.* Promontory, with nerve plexus upon it; *b.* fenestra rotunda; *c.* malleus; *d.* incus; *e.* stapes; *f.* pyramid with tendon of stapedius muscle; *g.* Eustachian tube; *h.* antrum freely communicating in this case with *i.* mastoid cells; *k.* the attic.

The tympanum.—The tympanum (fig. 4) is an irregular bony cavity, somewhat wedge-shaped in form with its edge downwards. Its broad outer wall is partially formed by the membrana tympani. Anteriorly it is prolonged into the Eustachian tube, posteriorly and superiorly it opens into the antrum mastoideum. The roof is formed by a more or less thin plate of bone which separates the tympanum from the cranial cavity. This

* The existence of this foramen, except as a result of disease, is doubted by most authorities.

plate of bone is sometimes very thin, and in rare cases even wanting; hence there is considerable danger of disease extending directly upwards from the tympanum to the meninges.

The broad inner wall presents, just behind the opening of the Eustachian tube, a rounded projection called the promontory (with grooves on it for the tympanic plexus); posterior to and above this, at the bottom of a deep pit, is the fenestra ovalis, which is filled in by the foot-plate of the stapes; below the fenestra ovalis, overshadowed and protected by the adjacent promontory, lies the fenestra rotunda with its membrane stretched over it. Further back we find a small conical projection called the pyramid; this contains the stapedius muscle, the tendon of which passes through a perforation at the apex, and is inserted into the head of the stapes.

The aqueductus Fallopii, containing the portio dura, is seen as a rounded ridge upon the upper and posterior part of the inner wall, and then passing downwards forms a posterior relation to the tympanum. This ridge, by its projection, slightly constricts the tympanic cavity, and the constriction is almost completed by the malleus and incus and folds of mucous membrane, so that a small portion is practically cut off the upper and posterior part of the tympanum. To the space thus cut off the special name of *attic* (fig. 4, *k*) has been applied. That portion of the attic which bulges forward anteriorly, lying a little above the deeper end of the meatus, and containing the heads of the malleus and incus, has been further dignified by the term Recessus Epitympanicus. The importance of the attic surgically and pathologically is, that posteriorly it communicates freely with the antrum mastoideum; that very slight inflammatory swelling of the mucous mem-

brane may completely shut off the attic from the rest of the tympanum, and that it is behind the Shrapnell's membrane.

Another muscle, the tensor tympani, arises in a tube above and parallel to the Eustachian tube, and makes its way along the upper surface of this inner wall, the tendon passing at right angles round the edge of a curled bony process—the processus cochleariformis—is inserted into the upper and posterior part of the handle of the malleus.

The ossicles in the adult are three in number; the malleus, incus, and stapes.

The malleus consists of a body, a neck, a long handle (inserted between the layers of the membrana tympani), a short process, and a long slender one called the processus gracilis. The body presents a rounded head for articulation with a corresponding concavity in the adjoining bone, the incus, this articulation being a true one.

The incus, shaped like a molar tooth, consists of a body and two processes. The body, as before stated, articulates with the malleus, and the tip of the longer process with the stapes. The shorter process is fastened by means of a ligament to the posterior wall of the tympanum.

The stapes is stirrup-shaped as its name implies. Its head articulates with the incus, and the foot plate is fixed into the fenestra ovalis by an annular ligament; nearly the whole of this ossicle being contained in the deep pit already mentioned.

The chorda tympani nerve enters the tympanum by a small opening just behind the membrana tympani, passes across its upper portion (between the long handle of the malleus and the long process of the incus) and

disappears by a similar opening in front of the membrana.

The cavity of the tympanum contains air supplied to it by the Eustachian tube, and is lined with mucous membrane continuous with that tube. The epithelium of this mucous membrane varies considerably in type according to its position; the ciliated columnar variety found near the Eustachian tube gradually changes to the single layer of tesselated epithelium, which, as already described, covers the inner surface of the membrana tympani.

Pathologically it is most important to bear in mind, *(a)* that this mucous membrane is continued over the ossicles as well as over the cavity generally, for probably the deafness in chronic middle ear catarrh chiefly arises from the adhesions and thickening of the mucous membrane of the ossicles and the consequent impairment of their mobility; the stapes is especially liable to become fixed by adhesive bands, binding it to the walls of the pit in which it is situated; *(b)* that the folds produced by reflections of this mucous membrane form pockets, which occasionally become the site of localised collections of inflammatory products; the most important of these pockets (Prussak's space) is situated directly behind Shrapnell's membrane; *(c)* that this mucous membrane is in some parts in such intimate connection with the periosteum of the bone, that the two together form a single membrane, and hence the tendency of middle ear suppuration to involve the bone.

Eustachian tube.—The Eustachian tube leads from the naso-pharyngeal space to the tympanum, and is nearly one inch and a half long.

The pharyngeal end is composed of cartilage and fibrous tissue, and forms about two-thirds of the tube;

the remaining one-third, the osseous portion, passes

FIG. 5.—Transverse section of the cartilaginous portion of the Eustachian tube × 10 diam. Drawn from a preparation of the late Prof. Burckhardt-Merian.

a. Tensor palati. 1. Slip attached to the sphenoid bone. 2. Slip inserted into the curled margin of the cartilage, which acts by pulling down the curled margin, and thus opens the Eustachian tube. 3. Slip inserted into the aponeurosis attached to the membranous wall of the Eustachian tube; its action is directly to open the tube. 4. Salpingo-pharyngeal aponeurosis. *b*. Cartilage of the Eustachian tube. *c*. Eustachian tube. *d*. Levator palati, seen in transverse section, on contracting it pushes the tube upwards and thus tends to open it. *e*. Sphenoid bone.

through the temporal bone parallel, and in close relation to the floor of the cranial cavity.

The cartilaginous portion is shaped like a flattened funnel, with its large end opening into the pharynx and its small end backwards. The inner wall is formed by a plate of cartilage curled round at the top, and the outer chiefly by fibrous membrane. The bony portion forms an ordinary funnel of smaller dimensions, its larger end opening into the tympanum, and its smaller into the cartilaginous part of the tube. Thus, the narrowest point of the whole tube (isthmus) will be found in the osseous portion just at its junction with the cartilaginous, and here the opening is so small that it will scarcely admit a very fine probe.

The Eustachian tube is lined with ciliated columnar epithelium, the cilia working so as to remove mucus from the tympanum to the pharynx, this important function being no doubt much interfered with in chronic Eustachian catarrh.

Under ordinary conditions the Eustachian tube is just patent, but not sufficiently so for the due admission of air to the tympanic cavity; but during deglutition, yawning, and certain other movements, the tube is opened so as to afford a free supply. This opening is affected by portions of the tensor palati and levator palati muscles which act upon the mouth of the cartilaginous tube, the chief factor being, no doubt, the slip *a*, 3, fig. 5, which is inserted into the membranous wall of the Eustachian tube.

Mastoid antrum.—This is the name given to a cavity situated at the junction of the petrous, squamous, and mastoid portions of the temporal bone (fig. 4, *h*). It is usually described as being one of the open spaces or air cells of the mastoid process, but on account of its posi-

tion, its size, its constant presence even in early life, and its surgical and pathological importance it is better to consider it quite separately. Generally speaking it is roughly ovoid in shape, but it varies a good deal both in form and size. Its relations to the surrounding structures are of no little importance. It is separated from the cranial cavity above by the extension of the thin bony plate (tegmen) covering the attic; behind and below it usually communicates with the air cells of the mastoid process, when these exist; in front it is continuous with the attic. It approaches nearest to the surface of the bone at a point immediately behind the opening of the osseous meatus, at which point a slight depression may be felt; this is taken by the surgeon as a guide for the use of the chisel or drill. The bone in this region varies a good deal in thickness; it may be that less than a quarter of an inch has to be cut through before the cavity is reached, but on the other hand, it may sometimes happen that over an inch has to be traversed.

The antrum is lined with closely adherent mucous membrane, but its walls, unlike those of the attic, are reticulated, and it has been suggested that it secretes and acts as a reservoir for the lubricating fluid of the tympanum.*

Mastoid process.—The internal structure of the mastoid process is by no means constant. In the infant there are no air-cells, and they may even be entirely absent in the adult, or, if present, may vary much in size and number. We may in fact have four distinct types of mastoid formation, viz:—

* An excellent description of the anatomy of the antrum will be found in Mr. Arthur Cheatle's paper, "The Mastoid Antrum in Children," *Lancet*, vol. ii., p. 1264, 1892.

1. *The Pneumatic*, in which the whole or nearly the whole of the process is occupied by air-cells communicating freely with one another and with the antrum, and lined with mucous membrane continuous with that found in the latter cavity.

2. *The Diploëtic*, in which the cells are very small, do not contain air, but are filled with diploëtic tissue.

3. *The Pneumo-diploëtic*, in which there is an admixture of the two preceding types.

4. *The Sclerosed*, in which the whole process is made up of compact bone with neither air-cells nor diploëtic tissue.

Surgically and pathologically the condition of the mastoid process is of great importance. In suppurative inflammation of the attic for instance, if the process is of the pneumatic variety, and especially if the air-cells are large and communicate freely with one another, the pus can readily find its way to the surface; but on the other hand in the diploëtic, and still more in the sclerosed types, the obstruction to the passage of the pus is so considerable that there is a very great risk of the inflammatory process extending inwards to the cranial cavity.

Although the tympanum (including the attic) and antrum may thus be considered as forming, anatomically, one continuous cavity, this cavity must be regarded as divided pathologically into two by the malleus, incus, &c., in the manner described on page 11 ; so that a perforation of the membrana tympani below the level of the ossicles leads directly into the anterior cavity or tympanum proper and does not involve the antrum, whereas a perforation above the ossicles (in the membrana flaccida) is a more serious matter, leading as it does into the posterior or antro-attic cavity which is much less accessible to treatment.

Perceptive Apparatus.

The perceptive apparatus consists of:—

1. The internal ear (containing nerve terminations).
2. The auditory nerve.
3. The auditory nerve centre (in the brain).

The internal ear.—The internal ear is contained in the substance of the petrous bone. It consists of cavities hollowed out of this bone, called the bony labyrinth, and of a complex arrangement of membranous tubes and sacs within it, the membranous labyrinth. The whole is filled with fluid; that outside being called *epilymph*, and that within the membranous labyrinth, *endolymph*.

Externally, the bony labyrinth is in relation with the tympanic cavity. In the macerated skull the two are actually in connection by means of the fenestræ ovalis and rotunda; but in the ordinary condition direct communication is cut off by the plate of the stapes which is inserted in the fenestra ovalis, and by a membrane filling in the fenestra rotunda.

Internally, the bony labyrinth is separated from the meninges of the brain by a considerable thickness of the dense petrous bone. Through this bone passes the internal auditory meatus which contains the facial nerve (portio dura), and the auditory nerve (portio mollis), the latter being distributed to the internal ear.

The bony labyrinth consists of three parts; the *vestibule* in the centre; the *cochlea* in front; and the *semi-circular canals* behind.

The vestibule is somewhat oval in shape; on its outer wall is the fenestra ovalis, into which the plate of the stapes is fastened by means of an annular ligament. Its anterior wall has an opening into the cochlea,

while on the posterior side there are the five openings of the semi-circular canals.

The semi-circular canals are three in number, and each one is placed at right angles to the other. Thus, one is horizontal, another vertical, with its axis from side to side, while the third is vertical, but has its axis from back to front. Although named semi-circular canals, they in reality describe more than a half circle, and as both ends open into the vestibule a whole circle is completed in each case.

At one end of each of these canals there is an enlargement of the tube to about twice its diameter; this enlargement is called the *ampulla*. Each ampullated end enters the vestibule separately, as does also the smaller end of the external semi-circular canal; but the smaller ends of the superior and posterior canals unite before entering the vestibule, and so only form one opening between them. Thus there are only five of these openings into the vestibule instead of six.

The membranous labyrinth of the vestibule consists of two sacs, the *utricle* and the *saccule*.

The utricle is behind and somewhat above the saccule; it is oval in shape, and into it open the three membranous canals. The utricle is adherent at one point to the saccule, and at another to the bony wall of the vestibule. It is composed of a fibrous membrane lined inside by epithelium, which, at the point of attachment to the wall, is modified for the reception of the nerve endings; this spot is called the *macula acustica* (see fig. 6).

From the surface of the macula project a number of stiff cilia, embedded in a layer of mucoid material containing crystals of carbonate of lime; to these crystals the special term *otoliths* has been applied.

The membranous labyrinth of the semi-circular canals has the same shape and modifications as the bony case or labyrinth, to which it is attached on the outer wall

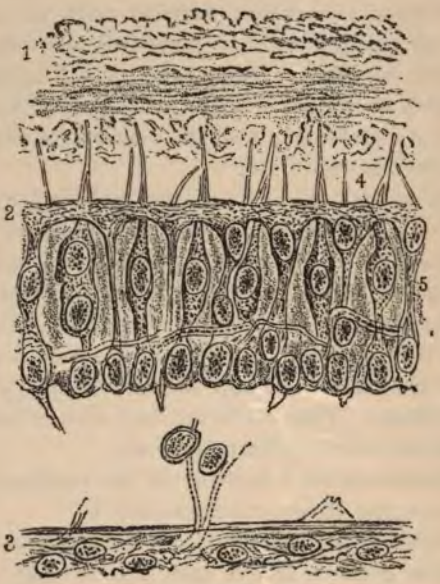

FIG. 6.—Transverse section of a portion of the macula acustica, × 750 diam drawn from one of the author's preparations.*

1. Otolith mass into which the long cilia are projecting; the otoliths themselves having been dissolved out. 2. Membrana reticularis limiting the nerve epithelium and through which the cilia pass. 3. Membrana propria blended with the periosteal tissue below, and accidentally detached from the nerve-epithelium. Broken nerve filaments are seen passing between. 4. A thorn-cell, or cell terminating in a thorn-shaped cilium. 5. A bristle-cell, or cell terminating in a bristle-shaped cilium.

of the circle. Its structure is similar to that of the utricle; and each membranous ampulla presents a crest

* "The Termination of the Nerves of the Vestibule and Semicircular Canals." *Quar. Jour. Mic. Science*, 1876.

projecting into its interior, the epithelium on which is modified for the reception of the nerve. This crest is named the *crista acustica*, and is very similar in structure to the macula acustica, but the cilia are longer, and the otolith mass forms a sort of cap over the crest.

The utricle and semi-circular canals together form the *posterior labyrinth*, and this is probably devoted to the sense of motion and equilibration. When regarded as a whole the posterior labyrinth will be seen to consist of three complete circles, the utricle uniting the ends of each semi-circular canal.

The cavity of the utricle is not directly connected with that of the saccule at their point of contact, but only indirectly united by means of a small V-shaped duct.

The saccule is spherical in shape; smaller than the utricle, but similar in structure; it also presents a similar macula acustica. A small duct, *ductus reuniens*, leads from its lower and anterior wall to the membranous labyrinth of the cochlea. The saccule together with the far more important ductus cochleæ, to be described immediately form the anterior membranous labyrinth, which is concerned with the function of hearing.

In the cochlea (fig. 7), the bony and membranous portions are so intimately connected that they must be described together, and in such description the axis or modiolus is always considered the centre and the apex as its upper portion. It is shaped like the inside of a snail's shell, and consists, like it, of a spiral tube diminishing towards its apex. This tube takes two and a half turns, and is divided longitudinally into two parallel scalæ by the *lamina spiralis*, a bony plate projecting at right angles from the axis or *modiolus*. This division is completed by a membranous extension of the

plate, *lamina spiralis membranacea*, which is attached to the outer wall of the cochlea by means of a cushion of fibrous tissue, the *ligamentum cochleæ*. From the upper margin of the bony lamina spiralis, not far from its outer edge, springs a very delicate membrane, *the membrane of Reissner*, which passes outwards and upwards to the upper part of the ligamentum cochleæ, thus cutting

FIG. 7.—Section through the centre of the cochlea, × 8 diam., by the author.
a. Auditory nerve. *b*. Ganglion spirale. *c*. Scala tympani. *d*. Scala vestibuli. *e*. Scala media or ductus cochleæ. *f*. Lamina spiralis. *g* Ligamentum cochleæ *h*. Membrane of Reissner.

off a small triangular tube, the *ductus cochleæ* or *scala media*. The remaining upper portion of the tube is called the *scala vestibuli* because at its lower end it opens into he cavity of the vestibule. The lower division of the tube has been named the *scala tympani*, because it leads at its lower end to the fenestra rotunda, and is there only separated from the tympanic cavity by the

membrane of the fenestra. The scalæ vestibuli and tympani unite at the apex of the cochlea.

The ductus cochleæ or scala media forms the membranous labyrinth of the cochlea. It consists of a tube, triangular in section, following the general spiral, and terminating blindly at each end; but near its lower extremity (the base of the cochlea) the ductus reuniens opens into and connects it with the saccule.

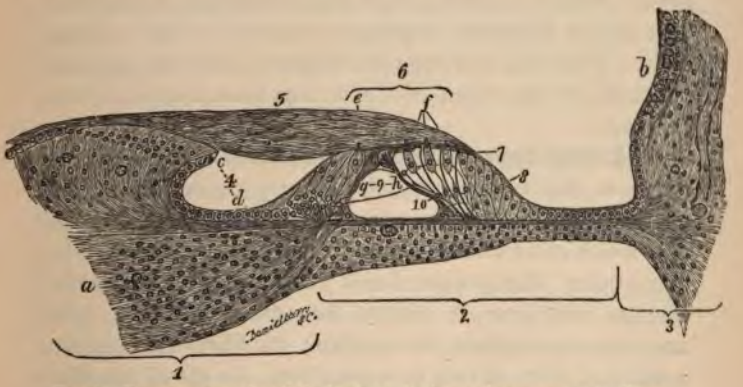

FIG. 8.—Transverse section of the lamina spira is membranacea, × 150 diam. 1. Lamina spiralis ossea (*a*) nerve. 2. Membrana basilaris. 3. Ligamentum cochleæ, (*b*) stria vascularis. 4. Sulcus spiralis, (*c*) upper lip, (*d*) lower lip. 5. Membrana tectoria. 6. Hair cells; (*e*) inner, (*f*) outer. 7. Membrana reticularis. 8. Supporting cells. 9. Rods of Corti; (*g*) inner, (*h*) outer. 10. Deiter's cells.

Although the tube is triangular in section throughout, its size does not remain the same; and curiously enough, instead of diminishing, its width actually increases from the base upwards, so that it follows inversely the general diminution of the spiral.

The base of the ductus cochleæ or scala media, is formed by the membranous lamina spiralis, and a small portion of the bony lamina; its roof by the sloping membrane of Reissner, and its outer wall by the liga-

mentum cochleæ. It is lined with epithelium variously modified. The portion which lies on and forms part of the membranous lamina spiralis is called the organ of Corti, and receives nerve terminations. This organ of Corti consists essentially of two rows of rod-like bodies, *rods of Corti* (fig. 8), and of several rows of ciliated cells. The cilia are stiff, but not nearly so large as those of the vestibule; they are embedded in a mucoid layer (membrana tectoria), which, however, contains no otoliths. The nerve filaments terminate chiefly in the ciliated cells. The rods and the cilia lengthen with the general widening of the organ of Corti from base to apex of the cochleæ.

Auditory nerve and nerve centre.—The auditory nerve is the eighth cranial, formerly described as the portio mollis of the seventh. It is very soft, and therefore much more liable to injury from pressure than its companion, the portio dura. It enters the internal meatus, and there it divides into two branches. The anterior one supplies the cochlea; its fibres pass up the modiolus, then through a ganglion, *the spiral ganglion*, and terminate in the organ of Corti. The posterior branch at its origin contains a number of ganglionic cells; it divides into five branches to be distributed to the two maculæ acusticæ, and the three cristæ acusticæ. These nerves throughout their whole course are contained within the bone until they arrive at the nerve-epithelium.

According to Ferrier* the auditory centre is situated in the superior temporal convolution; the auditory nerve is in relation with this centre through the lower fillet of the opposite side, and thence, by means of the posterior tubercles of the corpora quadrigemina and corpus geni-

* "The Croonian Lectures on Cerebral Localization," June, 1890.

culatum internum and medullary fibres of the cortex. There is thus a decussation of auditary fibres very similar to that which takes place in the case of the optic nerves.

As already mentioned (p. 2) the vestibular fibres from the semicircular canals pass through the cerebellum.

Lower down the auditory nerve receives fibres from nuclei seated in the floor of the fourth ventricle between and in front of the restiform bodies.

Functions.

Having now briefly considered the anatomy of the auditory apparatus, it may be well to add a few words upon the rôle which the various parts play in the production of the sense of hearing.

The collecting power of the human auricle is of slight value, but still, to a certain extent, the sound waves are directed by it into the meatus. The meatus conducts them to the tense membrana tympani, and this readily picks them up and transfers them to the chain of ossicles with which it is in intimate relationship. These mobile solid bodies, vibrating as a whole, carry on the sound waves to the fluid of the internal ear by means of the foot-plate of the stapes.

The membrana tympani and the chain of ossicles are necessary on account of the fact that sound-waves, passing from a gaseous medium (in this case, the air) into a fluid one (here represented by the epilymph), are almost entirely reflected and lost. But the tense membrana tympani is able readily to pick up the sound-waves from the gaseous medium and so transmit them to the solid ossicles, and through these they are trans-

ferred to the fluid medium without any appreciable loss.

These sound waves will now pass through the fluid of the anterior labyrinth and affect the organ of Corti in some way not yet determined. The nerve terminations become excited, and the sensations are carried along the portio mollis to the auditory nerve centre in the brain. The *pitch* of the sound is probably appreciated in the cochlea; each minute division of a note affecting a corresponding portion in the spiral scale.

The membrane of the *fenestra rotunda* or secondary tympanic membrane, does not appear to have any direct auditory function; probably, by its elasticity, it serves to relieve the pressure to which the delicate structures contained within the bony labyrinth would otherwise be subjected by the movements of the stapes.

The saccule, which is the only part of the labyrinth found in invertebrates, very possibly can only appreciate the *intensity* of a sound.

Formerly the appreciation of the *direction* of sounds was believed to be the function of the semi-circular canals, but this is not the case; for it is easy to prove that we only learn the direction from whence a sound proceeds by comparing (unconsciously) its relative intensity in the two ears. We cannot discover the position of a noise which is produced at an exactly equal distance from the two ears. Again, a person who has entirely lost the hearing on one side is quite at a loss to know the direction whence sounds come. The latter fact should make the surgeon always caution a patient who has suddenly lost the hearing of one ear, to depend on his eyes and not on his remaining good ear, when crossing dangerous thoroughfares.

The function of the semi-circular canals and utricle, the posterior labyrinth, is now generally accepted to be

that of sense of motion and consequent sense of equilibrium.

The sensation is produced in the following way. If we consider that each semi-circular canal with the utricle forms a complete circle; that at one point of this circle there is a crest covered with nerve terminations; and further, that the whole is filled with liquid; it follows that when the body is turned in the axis of this circle, the fluid tending to remain stationary, the effect of a current in the opposite direction will be the result. This current impinging on the crista acustica will excite the nerve terminations, and thus the sensation is produced.

Now the axes of the three semi-circular canals being at right angles to each other we get sensations of movements in different directions. In all probability the crista of each semi-circular canal is affected by movement of the fluid in one direction only, the corresponding canal on the other side being affected by currents in the opposite direction.

CHAPTER II.

Methods of Examining the Ear—Objective and Subjective.

Before proceeding to the description of the various injuries and diseases to which the ear is subject, it will be convenient to devote a chapter to the methods at our disposal for examining the condition of this organ, and of the neighbouring parts in relation with it. Although the middle and internal ears are almost entirely hidden from view, and therefore their examination is rendered very difficult, yet by making use of the subjective as well as the objective means now to be described, we are able to form a very satisfactory estimate of the condition of any part of this complicated apparatus. The objective examination of the ear resolves itself into the following:—

1. Observation by the naked eye, of the auricle and its neighbouring parts, including the opening of the meatus. To this may be added, observation by means of touch, *i.e.*, examination by the finger of the parts around the auricle.

2. Examination by the aid of the speculum, of the meatus, membrana tympani, and sometimes of the tympanic cavity beyond.

3. Examination of the pharynx by the naked eye, and of the nose and naso-pharynx by means of rhinoscopy and the finger.

4. Examination of the Eustachian tube and tympanum by means of inflation and the diagnostic tube.

The subjective method consists in measuring the hearing power, not only of the apparatus as a whole, but also of the essential or nervous portion by itself. In other words, the hearing power of the conducting and perceptive portion together, and of the perceptive portion alone, must be carefully gauged.

Objective Methods.

1. **Inspection** by means of the naked eye, of the parts around the auricle, I need scarcely say, is of great practical importance. Note should be taken of the state of the skin, &c., so that swelling, inflammation, boils, eczema, tumours, injuries, collapse, malformations, facial paralysis, &c., may not be overlooked. As, however, these points will be referred to in detail in future pages, there is no need to do more here than to remind the reader of the value of this mode of examination.

Inspection in many cases may be supplemented with advantage by palpation. Thus, hard tumours may be recognised, fluctuations felt, and the seat of tenderness discovered by the use of our fingers.

With regard to palpation the following general rules will be found of practical value. Tenderness on pressure of the tragus indicates inflammation of the meatus; tenderness on deep pressure below the auricle denotes inflammation of the middle ear, (this will be readily understood when the proximity of the glenoid cavity to the tympanum is remembered); tenderness on pressure or on percussion of the mastoid process indicates mastoid inflammation.

2. **The speculum,** although an exceedingly simple

instrument, is perhaps the most important auxiliary that we possess for the examination of the ear; its value mainly consisting in straightening the meatus so that a light can be readily thrown in.

There are numerous forms of specula, which may be divided into the long, short and dilating varieties.

The long (fig. 9) generally consists of a long narrow funnel, oval in section so as to accommodate itself to the meatus. There are several modifications of these, and they sometimes go by the name of Wilde's, Toynbee's or Grüber's specula. They are inserted right into the osseous meatus.

Formerly this was the kind most generally used, but

FIG. 9.—Long Ear Speculum.

it has the serious disadvantage of producing much irritation and even pain during introduction, for which reason I have always preferred one of the shorter specula; and in this opinion I believe most aural surgeons concur.

The short speculum is only introduced into the cartilaginous part of the ear, but as that is the curved portion, this, as a rule, is all that is necessary, and its introduction causes no pain whatever.

I find it is a considerable advantage to have the speculum circular at the narrow end, instead of oval as they are sometimes made, as it allows of the instrument being turned round, which is often desirable.

The wide end is usually about $\frac{3}{4}$ inch diameter, but I like mine (fig. 10) to be about double this size, as the fingers holding it are then more out of the way, and the light may also be thrown in at a wider angle if necessary. As the size of the meatus varies, according to

FIG. 10.—Short Ear Speculum.

whether the patient is a child or an adult, the surgeon should have a set of at least three specula, the narrow ends of which should measure from $\frac{1}{5}$ inch to $\frac{1}{7}$ inch diameter.

FIG. 11.—Operating Ear Speculum.

These specula are made of metal, vulcanite, &c. I much prefer them made of silver, very thin so that as little space as possible is lost.

When operating with such an instrument as a pair of forceps, I use a speculum (fig. 11) from the narrow end

of which a portion has been removed so as to allow of the forceps being more fully opened.

The dilating speculum (fig. 12) consists of two blades like other bi-valve specula. These are introduced when closed, and then separated either by means of a screw

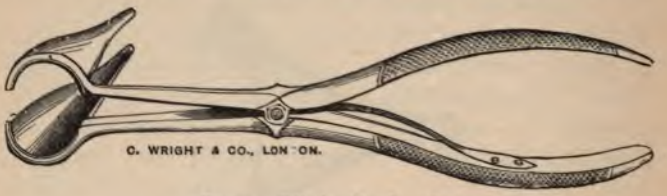

FIG. 12.—Dilating Ear Speculum.

or a handle. This kind is occasionally useful when the meatus is much flattened or collapsed.

Siegle's pneumatic speculum (fig. 13) is an ingenious modification of the speculum devised for the purpose of

FIG. 13.—Siegle's Pneumatic Speculum.

examining the mobility of the membrana tympani. It consists of an ordinary short speculum with its narrow end covered with india-rubber to make it fit the meatus more accurately. A piece of glass fits closely and obliquely across the wide end, and below this is a small

opening from which proceeds a piece of india-rubber tubing, terminating in a ball or in a mouth-piece; or a small force pump capable of minute gradations of pressure may be attached (Delstanche).

This speculum must be firmly fixed in the ear so as to prevent any entrance or exit of air. The membrane is then inspected, and at the same time the atmospheric pressure in the meatus is alternately increased and diminished, by pressing and relaxing the india-rubber ball, by using the mouth-piece, or by carefully working Delstanche's force pump. If the normal mobility exists, the effect of this alternating pressure is to move the membrane inwards and outwards. By this method the surgeon can tell if the membrane is free or whether it is fixed by adhesions.

Modes of illumination.— 1. By *direct daylight*.— The speculum having been introduced into the meatus, the head of the patient is placed so that the light from a window falls straight into the ear. This is frequently all that is necessary, but it has the great disadvantage of requiring the head of the patient to be adapted to the light, and thus the least deviation on his part stops the examination.

2. By *reflected daylight*.—A mirror, either held in the hand, or still better, fixed on the forehead in a manner similar to that employed with the laryngoscope, is used to throw the light—best taken from a northern aspect—into the ear.

This is one of the best modes of illumination, because the light may thus be easily adapted to the patient's ear, so that any slight movement on his part can be readily followed up by the surgeon. Moreover, with this appliance there is rarely any difficulty in throwing in a good column of light.

In choosing a mirror for this purpose, two points must be observed; first, it should be sufficiently large, and second, its focus should suit the sight of the surgeon.

FIG. 14.—Benzoline Lamp.

3. By *direct artificial light*, a very handy mode for the purposes of ordinary examination.

The old-fashioned candle-lamp with a reflector behind it does very well; the benzoline lamp (fig. 14) sold by most surgical instrument makers, is still better; but by far the best direct artificial light, is the small incandescent

lamp (photophore) introduced by Trouvé of Paris (fig. 15). The globe has a bull's eye lens in front and a reflector behind, and the lamp is fixed to the forehead in the same way as the laryngoscopic mirror. The current may be obtained from a primary battery, an accumulator, or still better from the electric main reduced to 6 volts.

FIG. 15.—Trouvé's Photophore.

4. By *indirect artificial light*, reflected from a laryngoscopic mirror fixed on the forehead. The source of illumination may be either an Argand gas burner or the electric light (fig. 16), a convex lense being fixed in front for the purpose of concentrating the rays. Unless the lamp itself is powerful and very freely moveable, it is somewhat difficult to adapt the patient's ear to the light, but the lamps used for this purpose have been much improved of late, especially when the electric

light is available, in which case I consider this method of illumination one of the most valuable that we possess. It may be useful to remind the beginner that the lamp, &c., should always be arranged so that the light may fall directly upon the mirror.

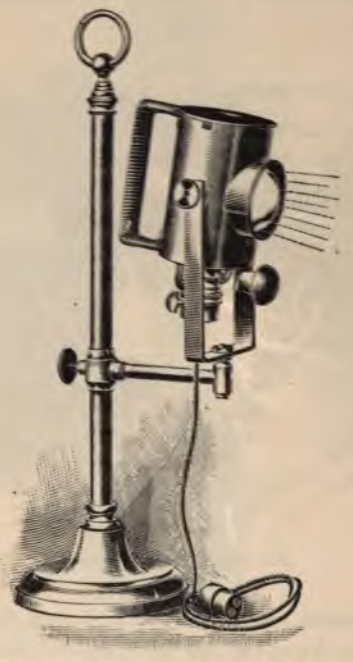

FIG. 16.—Dr. Greville MacDonald's lamp.

Occasionally sunlight, direct or reflected from a plane mirror is used, but personally I find it too dazzling.

Brunton's auriscope.—This very ingenious apparatus combines the speculum with the illuminating instrument (fig. 17). It consists of a tube, one extremity of

which fits on to the enlarged end of the speculum, and to the other extremity a lens is adapted. At about the middle of this tube a slanting mirror with a hole in the centre is adjusted, the light being brought to this by means of a funnel inserted at right angles into the tube. The light thus thrown on to the mirror is reflected by it straight into the meatus, and the observer, looking down the tube through the lens and

FIG. 17.—Brunton's Auriscope.

through the centre of the mirror sees a slightly magnified image of the illuminated parts.

This auriscope is used by some aural surgeons in preference to all other methods of illumination.

Introduction of the speculum.—This may, at first sight, appear to be too simple an affair to require directions, but some little practice is really needed before

the speculum can be properly introduced so as to enable the surgeon to obtain a good view.

The speculum, warmed by friction, being held between the first finger and thumb of the left hand, the auricle should be caught between the other fingers of the same hand, and drawn upwards and outwards with a slight twist so as to straighten the meatus; the speculum can then be readily inserted. When the meatus is much collapsed, both hands should be used.

Care must be taken that the long axis of the speculum is adapted to that of the meatus, otherwise it may point to some portion of its walls instead of to the membrana tympani, and so occasion an erroneous diagnosis. For instance, should there chance to be a somewhat thick layer of cerumen on the floor of the meatus and the speculum be directed on to this, it will appear as though the whole meatus was completely filled by a plug of wax.

Appearance of the normal meatus and membrana tympani.—It will be convenient here to make a few remarks upon what is seen in a normal ear by the help of the speculum.

As the speculum is being introduced into the cartilaginous portion of the meatus, a number of extremely fine hairs will be noticed; these are sometimes very abundant, and may then obscure the view until the speculum has passed them. Besides these, a thin layer of cerumen will be noted, and this, usually thicker at the floor, may sometimes enter the speculum and so hide the deeper parts. When the speculum (short) is fully introduced, only the osseous meatus and the membrana tympani can be seen.

The osseous meatus presents a smooth pale pink appearance. The membrana tympani (see frontispiece)

which forms the background of our view, is tense, smooth, and of a pearly semi-transparency, like a stretched piece of goldbeater's skin. The centre, *the umbo*, is more retracted than the rest, and passing upwards and slightly forwards from this centre, the handle of the malleus is seen between the layers of the membrane. The handle of the malleus terminates near the upper margin of the membrana in a slightly pointed prominence, *the short process* of the malleus, and from this point indistinct folds or bands pass forwards and backwards; between these bands, just above the malleus, may be seen the membrana flaccida. But the whole of this upper portion of the membrane is ill-defined, and its junction with the meatus itself indiscernible on account of the obtuse angle at which they meet.

When the membrane is unduly retracted (in cases of Eustachian obstruction) the short process of the malleus and the upper portion of the handle become very prominent, as also do the folds already described, thus forming an anterior and a posterior pocket in which may be lodged debris of all kinds. At the upper part of the posterior pocket the long process of the incus may, even in the normal condition, sometimes be seen through the membrane.

A *triangular spot* or cone of light will be seen passing from the umbo, or retracted centre, forwards and downwards to the margin of the membrane, the apex of the triangle being towards the umbo and the base towards the circumference; the brightest portion is midway between these. This triangular spot is due to the crossing of the rays of light as they are reflected from the polished, concave surface of the membrane, and it therefore becomes altered in shape and brilliancy according to the degree of retraction and condition of the surface

of the membrane. Thus, if the membrane is a little too concave, the spot ceases before it reaches the circumference; and when the concavity is still greater it appears merely as a rounded bright spot close to the umbo. When the surface of the membrane has lost its polish, the triangular spot itself entirely disappears. To the surgeon these different appearances of the bright spot are therefore very useful indications in forming a diagnosis.

The anterior and lower margin of the membrane is frequently out of sight on account of the curvature of the meatus, the amount of which varies in different individuals.

When the membrane is partially lost by disease the inner wall of the tympanum comes into view. This will be found lined with a pink mucous membrane. The promontory (p. 11) is the portion most frequently seen, but in some rare cases, where nearly the whole of the membrane and the two first ossicles have been lost, an almost complete view of this inner wall may be obtained.

3. **Examination of the pharynx, nose and naso-pharynx,** by the naked eye, rhinoscopy and the finger.

When it is borne in mind that the Eustachian tube acts as a medium of communication between the naso-pharynx and the tympanum, it will readily be understood how it is that we find so many cases of ear disease dependent, either directly or indirectly, upon affections of the pharynx, the naso-pharynx and the nose. It is absolutely necessary therefore to examine these spaces in a systematic manner.

The pharynx may be examined in the ordinary way, using a spatula to hold down the tongue, and directing a good light into the throat; at the same time the patient should be requested to say 'Ah' so as to raise

the soft palate. The surgeon should especially look out for the following:—catarrh of the mucous membrane with or without thickening; granulations; adenoid growths; enlarged tonsils, and cicatrices of former ulcers.

In examining the nose we must first note whether the air passes through both nostrils; we may then, with the aid of a suitable speculum, a nasal probe, and a good light (anterior rhinoscopy), proceed to ascertain more exactly the condition of the parts. By these means we can detect malformations, polypi, spurs on the septum, diseases of the bone, hypertrophy and atrophy of the mucous membrane and erectile tissue, purulent and other discharges, &c., whilst of course ozæna will readily be recognised by its characteristic odour.

The naso-pharynx and posterior nares should next be explored. For this purpose the aural surgeon should accustom himself to rely upon digital examination. In the majority of cases the finger may readily be passed between the fauces and up behind the soft palate, where it will at once command the whole of the region in the neighbourhood of the openings of the Eustachian tubes and posterior nares. By this means we can detect adenoid growths and other tumours in connection with the naso-pharynx; hypertrophy of the mucous membrane and mulberry growths (Woakes) on the posterior extremities of the inferior turbinated bones; nasal polypi protruding into the space, &c.

Instead of making use of the finger many practitioners depend mainly on posterior rhinoscopy. The details of this method are very similar to those adopted for laryngoscopy, except that the small throat-mirror is turned upwards, and if necessary the soft palate may be drawn forwards with some kind of retractor, that recommended

by Cresswell Baber, and which is self-retaining, being one of the best.*

4. **Examination of the Eustachian tube and tympanum** by means of inflation and the diagnostic tube.

It is almost invariably necessary to examine the Eustachian tube so as to ascertain whether it is obstructed. This is done by means of the diagnostic tube combined with one of the following modes of inflation, viz: Valsalva's method, Politzer's method, or the catheter.

The diagnostic tube consists of a piece of india-rubber tubing two or three feet long, with or without ivory ends. One end is inserted into the patient's meatus and the other into that of the surgeon; thus the surgeon is able to hear the various sounds produced in the Eustachian tube and tympanum during inflation.

In the normal ear when the tympanum is inflated a dull click is heard; if a perforation exists a whistling is distinctly audible; while the presence of fluid is indicated by moist sounds. Other sounds of minor importance may also at times be heard, and some authorities lay great stress upon their diagnostic value; but it requires a very practised ear to appreciate rightly the value of any but the three just mentioned.

Methods of Inflation.

In the normal state we find that the Eustachian tube is constantly being opened, either by the act of swallowing or by some other movement of the pharynx. It is by this means that the air in the tympanum is renewed,

* For further information the reader is referred to Cresswell Baber's "Guide to the Examination of the Nose." (Lewis).

and the pressure on each side of the membrana tympani equalised. Under normal circumstances too, air may be pressed into the Eustachian tubes simply by holding the nose and making a slight expiratory effort.

Valsalva's method is merely a combination of the two above mentioned principles, and is more particularly applicable in slighter degrees of Eustachian obstruction. It is performed by holding the nostrils, closing the mouth, blowing out the cheeks and nose, and at the same time attempting to swallow. The swallowing opens the Eustachian tube, the air is then forced through the tube into the tympanum and can be felt distending the membrane. It rarely needs more than a little practice to succeed if the Eustachian tubes are not much obstructed. Sometimes when the patient is unable to do this, the desired result may be brought about by letting go the nostrils at the moment of swallowing. This little modification was pointed out some years ago by my colleague, Dr. Matheson.

Politzer's method.—This method of inflating the tympanum which was devised by Prof. Politzer, of Vienna, consists essentially in the use of a bag for the forcible injection of air through the nostrils at the moment of deglutition. It is performed as follows, viz.:—

The patient is given a sip of water to hold in the mouth which must be firmly closed, and the head thrown a little backward. With one hand the surgeon introduces the nozzle of an ordinary india-rubber bag (fig. 18, six to eight ounces capacity) into one nostril; with the other hand the nose is compressed against the nozzle so as to completely occlude the passages, and the patient now being told to swallow, the bag is squeezed forcibly as soon as the larynx is seen to move. During

the act of swallowing, not only is the Eustachian tube opened, but the soft palate is raised and the pharynx cut off from the nose, so that the column of air from the bag impinges almost directly upon the then open orifice of the Eustachian tube; we are thus enabled to

FIG. 18.—Politzer's bag. *a*. Simple form. *b*. Nozzle used by author. *c*. Peter Allen's form.

overcome a much greater obstruction than can be done by Valsalva's method.

The bag used on these occasions is termed Politzer's bag, and is probably one of the most valuable instruments that we aural surgeons possess.

Numerous modifications of this bag have been made.

Sometimes a valve is adapted to the bottom or to the neck of the bag, so as to allow of the entrance of air otherwise than through the nozzle. For ordinary purposes, however, I do not like this, for not only are the valves very liable to get out of order, but the complexity of the apparatus militates against its use; some manufacturers make matters even worse by placing a valve in the tube leading to the nozzle, in such a way as to interfere with the direct exit of air, thereby greatly diminishing the force of the inflation.

The late Peter Allen devised a double nozzle with cushions to press against the nostrils. This form is sometimes of service (fig. 18, *c*). Again, some aural surgeons prefer merely a short wooden nozzle connected with the bag (fig. 18, *a*), this has the advantage of obtaining the fullest possible force. Others like a long narrow india-rubber tube between the bag and the nozzle; this is handy for use, but much force is lost.

I prefer an eight ounce india-rubber bag, fitted with a piece of stout rubber tubing two inches long and of large calibre, mounted with a wooden nozzle which is oval in section and slightly bent (fig. 18, *b*). These nozzles are easily adapted to the nostril, and the tubing is neither small enough nor long enough to interfere with the force of the bag.*

Instead of swallowing water the patient may make a slight expiratory effort, as by whistling, or by pronouncing the word "hick," (as recommended by Prof. Grüber), aspirating the *h* well, the surgeon inflating at the same moment. With young children, too, none of these aids are required; using the bag when the mouth is firmly closed being all that is necessary for successful

* These are manufactured by Messrs. Mayer and Meltzer, and by Messrs. Hawksley and Co.

inflation. The expiratory efforts of crying facilitate the process.

Another modification of this method, which is sometimes very useful with nervous children, consists of a tube similar to the diagnostic tube; one end is introduced into the patient's nostril, while the surgeon puts the other into his own mouth and blows forcibly through it.

The Eustachian catheter.—Before the introduction of Politzer's bag the surgeon generally relied on the catheter for inflating the tympanum; and even now, this instrument, combined with Politzer's bag, is a very favourite and perhaps the most thorough method of inflation.

FIG. 19.—Eustachian catheter.

The catheter consists of a silver, vulcanite, or gum elastic tube from four and a half to six inches in length, curved at one end (fig. 19). This is introduced along the inferior meatus of the nose and so through into the Eustachian tube; the surgeon then inflates the tympanum, by means of a Politzer's bag adapted to the catheter.

Mode of introduction.—The introduction of the Eustachian catheter requires a good deal of knack, and even in practised hands it is in some cases impossible to pass it satisfactorily, on account of irregularities in the nasal passages.

These instruments should of course be kept surgically clean, and before use should be slightly warmed

by friction. The curved end is introduced into one nostril, keeping the beak close along the angle formed by the septum and the floor; by this means the surgeon will avoid getting into the middle meatus and so finding himself in a difficulty further on. When the catheter has passed the posterior nares it will soon encounter the back of the pharynx; this will be easily recognised by its tension, for it has been very aptly described as feeling like the out-stretched palm of the hand. The catheter should then be withdrawn about half an inch, and the point turned almost directly outwards, after which, on the catheter being again slightly pushed in, the point will enter the Eustachian tube. That it has so entered may be ascertained, first by noticing that the point is apparently grasped so as to give a slight resistance to withdrawal, and second by the result of inflation. On inflation by the mouth, if the catheter is in the Eustachian tube, a distinct and peculiar vibration is felt by the surgeon even when the Eustachian tube is too much blocked to be opened; and if opened the air may be heard entering by means of the diagnostic tube.

Now this little operation is always disagreeable to the patient and sometimes painful. Therefore it should be performed lightly and dexterously, and without the least forcing. At the same time it is well, as recommended by Sir William Dalby and others, to pass the catheter rapidly through the nasal meatus, as it will then produce less irritation; but should the point meet with any obstruction the catheter must be carefully humoured so as to pass on one side of it. The previous use of cocaine (5 per cent. solution) will relieve the patient of much discomfort, and should always be adopted when the mucous membrane is at all sensitive.

Frequently the nostril on one side is so much encroached upon by the septum, that there is not room for the entrance of the catheter. In such cases the instrument should be introduced through the other nostril, which will generally be found correspondingly large. For this purpose it is well to use a catheter with a sharper curve, it is then quite as easy to introduce it into the Eustachian tube as if passed through the corresponding nostril.

The use of the catheter has been very much superseded by the introduction of Politzer's bag, but when it is desirable to direct much force into the tube, or to introduce fluids, &c., into the tympanum then the catheter is preferable. Frequently too, when Politzerisation has wholly or partially failed, catheterisation will succeed. Again, when one Eustachian tube is unobstructed and the hearing good on that side, while the other one is blocked, the catheter should be used lest the healthy tympanum be over-inflated. This over-inflation, however, may frequently be obviated by causing the patient to press the tragus firmly into the meatus on the normal side, so as to back up the membrane with a resisting column of air; at the same time the head is tilted so that the ear to be inflated is uppermost.

Dangers of emphysema by catheterisation.—There is a rare form of accident that sometimes occurs through the use of the catheter. If its point should wound the mucous membrane so as to get beneath the surface, inflation will produce emphysema of the sub-mucous tissue of the pharynx and adjacent parts. Probably, however, this very rarely occurs except when the point has passed through an ulcer; and although it occasions excessive discomfort no really serious result from the

accident has been recorded. To diminish the risk of this accident, the point of the catheter should be well rounded and quite smooth.

I may here mention that there is one other method of inflation, and that is by means of a force pump. The air is highly compressed in a metal chamber and then allowed to escape suddenly through a catheter into the Eustachian tube, thus obtaining the effect of Politzer's bag only much more forcibly. This method requires to be used with the utmost caution; and although it may in certain cases be applied with advantage, there is some risk attached to its use. The late Dr. Turnbull had two cases of sudden death after employing it; and curiously enough, the post-mortems did not show evidence of the real cause of death.

Subjective Methods of Examination.

We have now to consider the methods of measuring the hearing power:—

1. As a whole; that is to say, of the conducting and perceptive portion together. 2. Of the perceptive portion alone.

The hearing power as a whole. In speaking of this we must take into consideration, first the pitch and next the intensity of the sound.

Pitch.—The human ear is able to appreciate sounds produced by vibrations ranging from 15 per second to 40,960 per second (Preyer). The limits, however, vary in different individuals. In disease, also, this limit is very often affected. Generally it is the low pitched sounds, those produced by the fewer number of vibrations, that are most easily lost. For instance, a patient

who can hear distinctly a conversation within five or six feet may be unable to hear thunder. Occasionally the reverse is met with, where the higher notes or those of some other parts of the scale are lost.

As a rule, when the patient fails to hear the higher notes the internal ear is affected, and when he loses the lower sounds the external or middle ear is at fault. Thus it is, as pointed out by Roosa,* that in internal ear deafness, the voice (vibrations of speech vary from 16 per second to 4,324 per second according to Wolf) is heard more distinctly than the higher note of the watch-tick; and in some cases of middle ear deafness the reverse is very marked. Again, in many cases of conduction (middle or external ear) deafness, the patient will hear notes of a Galton's† whistle of a higher pitch than those heard by an average normal ear.‡

More rarely it happens that the pitch of the sound is apparently altered, that is to say, the sound seems to the affected ear to be either sharper or flatter than it actually is. As this peculiarity usually affects one ear only, we shall find, if the alteration of the pitch is sufficiently great, that the patient will hear a single sound as a double one, because of its being differently perceived by the two ears. To ascertain which ear is at fault we must make use of the tuning fork. If this is sounded and brought first near one ear and then near the other, the patient each time imitating the note, the surgeon will be able to recognise the affected ear by the fact, that the patient will only sing the correct note when the fork is held near the normal ear.

* International Otol. Congress, Bâle, 1884.

† A small whistle devised by Sir Douglas Galton for the production of notes of the very highest pitch.

‡ Burckhardt-Merian, International Otol. Congress, Bâle, 1884.

The symptom is a very rare one, and when met with is generally associated with middle ear catarrh, and probably due to altered tension of the labyrinthine fluids produced by pressure of the stapes; this altered tension causes the sound to affect the lamina spiralis higher up or lower down the spiral than normal, and in consequence the sensation is carried by a different nerve-filament to the brain.* The condition is very annoying to the patient if he is a musician, but fortunately it readily yields to the ordinary treatment of simple middle ear catarrh.

For testing the defects in pitch, a series of three tuning forks, varying from 16 vibrations per second and upwards, together with a Galton's whistle for the very highest notes, may be employed.

Intensity.—We pass on now to the measurement of the intensity or loudness of the sound.

The hearing power, *i.e.*, the power of hearing sounds of a medium pitch, may be measured in normal ears and in a very large proportion of defective ones, by means of a watch, by the Acoumeter, or by the Sonometer.

A description of Politzer's acoumeter will be found in his work on *Diseases of the Ear*, page 164. It consists of a steel cylinder carefully tuned, and a percussion hammer; the whole so arranged as to produce a sound of constant intensity and pitch. The Sonometer is a complicated arrangement of microphone, telephone, two coils and a battery, with a graduated scale to indicate the hearing power. Undoubtedly these two form very accurate means of measurement, but for practical purposes the watch is more convenient.

Two watches should be kept for use; one with a hearing distance of from fifty to seventy inches, and

* I am aware that this explanation is not received by all, but it still appears to me to be the simplest and most probable one.

another of from twenty to thirty feet, the latter for very deaf cases. The average normal hearing distance of each watch is obtained by carefully measuring several normal ears; then by means of these watches and an ordinary tape measure, the surgeon can readily ascertain the amount of hearing distance possessed by the patient.

In applying this test, however, some little care must be taken lest the patient should fancy that he hears the tick further off than he really does. The best plan is, first to let the patient hear the watch close to his ear for a moment, and then taking it quite far off, gradually bring it nearer again until it just reaches the point where the ticking is unmistakeably heard. This distance being noted and compared with the normal hearing distance of the watch, we describe the hearing distance of the patient either in the form of a fraction or a percentage; thus, if the patient hears a fifty-inch watch five inches off, his hearing distance would be represented by $\frac{5}{50}$ or ten per cent. By keeping a record of the hearing distance in fraction or percentage, the surgeon is able to refer back at any future time for the purposes of comparison.

It must be remembered, however, that, as sounds decrease in intensity according to the square of the distance and not in a direct ratio, the hearing *distance* does not truly represent the hearing *power;* for instance, half the hearing power with a forty-nine inch watch, is not twenty-four and a half inches, but seven inches. Thus it will be seen, a very slight loss of hearing power will reduce the hearing distance to two-thirds or one-half.

As already stated, the watch tick is not heard so well as the voice in cases of internal ear disease; this must be taken into account when estimating the hearing

power in such cases by means of the watch. Again, the surgeon must be on his guard for those occasional instances of middle ear affection where the reverse holds good, or he may be very much misled. One of my patients afforded an admirable illustration of an extreme case of this kind. The watch hearing distance being sixty per cent., it would seem as though his deafness would be scarcely apparent, and yet he was unable to hear anything but very loud conversation with that ear.

The hearing power can also be gauged to a certain extent, though of course not with great exactitude, by means of conversation. But although this is a most valuable help to an experienced observer, it is only after much constant practice that the surgeon can rely upon it as a trustworthy guide.

Hearing power of perceptive portion alone, *i.e.*, internal ear.

If a sound is produced by the vibration of any solid body, and that body is placed in contact with the head, the sound waves will be carried, chiefly by means of the skull bones, direct to the internal ear.

For example, the tick of the watch held in the teeth may be distinctly heard through the bones of the skull Or a tuning fork sounded and brought in contact with any part of the head is similarly heard.

Now it is a curious fact, the reason for which is not yet fully understood, that whenever the conductors (the external or middle ears) are at fault, the skull sounds are heard more loudly. Thus, if a tuning fork is brought in contact with the bridge of the nose, and one ear deafened by closing it with the finger,* the tuning fork will

* The finger must not be pressed too firmly into the meatus, or else, as pointed out by Cresswell Baber, this phenomenon does not occur.

be heard distinctly in the deafened ear and probably not at all on the other side. Again, if, in a case of middle or external ear deafness, the vibrating prongs of a tuning fork are held close to, but not touching, the concha until the patient ceases to distinguish the note, and if then the button end of the fork be quickly applied over the mastoid process, it will be found that the sound is still distinctly heard; in cases of internal ear or nerve deafness, on the contrary, the reverse is the case, *i.e.*, the aërial vibrations are audible long after those conveyed by the skull. This method of using the tuning fork constitutes Rinne's test, and is the one most usually employed.

By these means we are generally able to ascertain, in a case of deafness, whether the fault lies with the conductors or with the perceptive portion of the organ. But we can go further, and with a fair amount of precision, measure and record the hearing power of the internal ear by the following method, for which we are indebted to the ingenuity of the late Gardiner Brown.

He found that by taking a tuning fork of medium pitch and applying it, when sounded, to the bridge of the nose of a person with normal hearing, the experimenter could feel the vibrations of the fork with his fingers for exactly the same length of time as the other could hear the sound of it. Gardiner Brown, therefore, proposed to measure the amount of skull hearing in patients, by counting in seconds—plus or minus—the lapse of time between the surgeon ceasing to feel the vibrations and the patient ceasing to hear them.

This method is sufficiently accurate to form a very valuable help in diagnosis, although it cannot always be regarded as an infallible guide.*

* When, at the International Medical Congress of 1881, Mr. Gardiner Brown described these observations, he met with much

Of the two methods above described I very much prefer Gardiner Brown's to that of Rinne's, and my plan of making use of it is as follows :—

The tuning fork being sounded, the stem is held between its finger and thumb, and its button end is firmly applied to the part to be tested (bridge of nose or mastoid process). Holding a watch in the palm of

FIG. 20.—Gardiner Brown's tuning fork.

my left hand, I request the patient to put his finger on that hand, and to lift his finger immediately he ceases to hear the sound; keeping my eye on the second hand of my watch, I can note exactly the time between his ceasing to *hear* the sound, and my ceasing to *feel* the vibration. This is marked plus or minus according as the patient hears it for a longer or a shorter time than I feel it.

adverse criticism, but I think this was chiefly because his critics were not sufficiently careful in their method of testing, and therefore failed to obtain successful results.

The tuning fork used should be of medium pitch, and it should also be one that vibrates well. I find that as a rule the sound is heard from a half to one second longer on the mastoid than on the bridge of the nose.

The following examples will illustrate the value of this test combined with that of the watch.

A. B. complained of marked deafness on the right side. Was found by the watch to have normal hearing distance on left side, whereas on the right the watch could not be heard at all.

A tuning fork applied to the bridge of the nose was heard the normal length of time, *i.e.*, o″; applied to the right mastoid it was 3″− ; and to the left mastoid ½″+.

Such indications point conclusively to a serious affection of the perceptive portion of the right ear.

C. D., another case of marked deafness of right ear only.

Watch-hearing distance	{	Right side, only on contact. Left, normal.
Tuning fork	{	On nose, 6″+, but sound all referred to right ear.
On mastoid	{	Right, 6½″+. Left, 4″+.

It will be noticed that the mastoid conduction on the left side is also apparently exaggerated, but this is due to the fact that the sound is really heard by, although it is not actually referred to the right ear. Bearing this in mind, the surgeon will readily diagnose this case as one where the conducting apparatus on the right side was alone at fault.

E. F. complained of considerable deafness of both ears.

Watch distance { Right, 1 per cent.
Left, 1 per cent.

Tuning fork { Nose, 3″−.
Each mastoid, 2½″−.

Such indications point to affection of the perceptive portion on each side.

Again, we may have both the conductors and the perceptive organs affected, as in the following case:—

G. H. complained of considerable deafness.

Watch distance { Right, 2 per cent.
Left, 2 per cent.

Tuning fork { Nose, 0″.
On each mastoid, ½″+.

Here the fault in the conductors (which would lengthen the time of the tuning fork hearing) is neutralised by the affection of the internal ear (which would diminish it).

To make proper use of this method the surgeon's fingers require a little education, so as to perceive the exact moment that the vibrations cease; further, he should never rely on a single experiment, but try it two or three times before he is satisfied with the accuracy of his patient; and lastly, he must make sure the patient *hears*, and not merely *feels* the vibrations of the tuning fork; this mistake is apt to be made if the patient is suffering from nerve deafness.

Although, as we have just seen, the tuning fork test is most valuable, yet it must not be regarded as absolutely infallible; for we occasionally meet with cases where the tuning fork indicates a *minus* quantity without the perceptive apparatus being defective. There is, however, seldom any real difficulty in distinguishing between the deafness due to external and middle ear disease, and that caused by affections of the

internal ear, especially when the objective signs obtained by the use of the tuning fork are confirmed by the subjective sensations of the patient. For instance, in marked middle ear mischief the patient will tell us that he hears better in a noise (see Chap. XIII.); that he appreciates notes of high pitch (tick of a watch) better than low notes (conversation). In nerve or internal ear deafness, on the other hand the patient hears distinctly worse in a noise; hears conversation better than the watch, and, in addition, loud noises frequently produce a sense of "jarring," which may be a source of much discomfort.

CHAPTER III.

MALFORMATIONS, INJURIES AND DISEASES OF THE AURICLE.

MALFORMATIONS of the auricle are usually due to the non-development of some part of the skeleton of elastic cartilage, the result of intra-uterine inflammation, adhesions, &c. They are frequently associated with imperforate, or imperfect meatus, and it is only in such cases that there is any appreciable loss of hearing.

These cases rarely call for any interference on the part of the surgeon, although their unsightly appearance frequently causes them to be brought under his notice by anxious parents.

Occasionally we meet with undue prominence of the auricle; but this condition also is of no real importance, unless the prominence is due to disease of the mastoid process, a disease which will be described later on.

The reverse of this, a flattening of the auricle to the side of the head, is of more frequent occurrence, especially among women and is induced by the habit, when long persisted in, of wearing the bonnet or cap tied tightly over the ears; as this is no longer a prevalent fashion, this malformation of the auricle does not occur so often as it formerly did. In itself it is of no importance unless it is associated with collapse of the meatus.

INJURIES.—In spite of the exposed position of the auricle, injuries to it are comparatively rare, this immunity being largely due to the elasticity of its framework.

Amputation of the entire auricle is a form of mutilation sometimes practised by barbarous people on their captives; but when once the wound has healed there is no call for surgical interference, and it is stated that there is no appreciable loss of hearing power.

Heavy ear-rings not only drag down the lobe but will sometimes cut right through it. This may cause inflammation requiring treatment according to ordinary rules; otherwise, beyond its ugliness, it is of little import and needs no special attention.

The cartilage may be accidentally divided by some instrument or sharp substance—such as broken glass, &c. In these cases, the hæmorrhage may be very smart on account of the blood-vessels being unable to retract readily. Torsion of the vessels and pressure are usually sufficient to stop the bleeding, but the pressure must not be too great, or necrosis of a portion of the cartilage may result. If stitches are necessary to bring the parts together, they should not be carried through the cartilage, but only through the cutis; wire or some other form of aseptic suture must be used, as ulceration and necrosis of the cartilage are readily set up.

In the mêlées of football the auricle is particularly liable to abrasions. The simplest treatment is of course all that is necessary, but it may be advisable to recommend the use of an "ear-guard."

Diseases of the Auricle.—Simple inflammation rarely affects the auricle alone, there is therefore no occasion to note that form of disease here. Nor is it necessary in a work like the present to enter into the subject of erysipelas, for although cases of facial erysipelas often commence by affecting the auricle, spreading from thence over the face, still, implication of this part does not necessitate any modification in the treat-

ment. It is, however, very important that the surgeon should bear this in mind, lest he mistake an early case of erysipelas of the face for simple local inflammation of the auricle.

ECZEMA very commonly affects this part, but will be considered with eczema of the meatus.

TUMOURS OF THE AURICLE:—

Fibrous.
Fibro-cartilaginous.
Cysts { Sebaceous. / Serous and Sanguineous.
Papillomatous.
Carcinomatous.

Fibrous.—Occasionally the auricle is the seat of fibrous tumours. These appear as rounded masses, either on the anterior surface of the auricle, where they may be easily mistaken for cysts, or on the lobule in the neighbourhood of the perforation made for the ear-ring, in which position they seem to be particularly prone to recur after removal. Ordinarily, enucleation in the usual way is all that is necessary, but in the case of those tumours which result from ear-piercing, the removal must be very free and complete.

Fibro-cartilaginous tumours are also met with, growing from the cartilaginous skeleton. These are very rare, but do not differ from similar tumours in other parts of the body, and should be removed in the ordinary way.

Sebaceous cysts are very common in the skin of the lobe and anterior surface of the concha. They result from the closure of a sebaceous gland and the inordinate increase of its contents, and are very liable to inflammation and suppuration. In some cases the simple evacuation of the contents is sufficient to destroy the cyst, but more frequently it is necessary to dissect out the cyst-wall.

When, from former inflammation, the cyst-wall is too adherent to be dissected out, its secreting surface should be thoroughly destroyed by means of the sharp spoon or by the application of some such escharotic as tincture of iodine, pure carbolic acid, &c.

Serous and sanguineous cysts, hæmatoma auris.—The upper part of the anterior surface of the auricle is sometimes subject to a peculiar form of cyst, which has been called hæmatoma auris or othæmatoma. This occurs more frequently, though not exclusively, in lunatics; it may be caused by a blow, intense cold, or by some interference with the trophic innervation of this part. It appears as a swelling filling up the concavity of the auricle and frequently bulging outwards; it results from a separation of the closely adherent skin from the cartilage, and the extravasation of serum or blood between these two. Many authors describe the extravasation as usually consisting of blood, but according to my experience it is far more frequently serous. Again, some of the older authorities assert that this disease occurs only in the insane, but this is now generally admitted to be by no means the case.

If allowed to remain unmolested a part of the contents is absorbed, and part becomes organized, causing a considerable amount of thickening, giving the auricle a very unsightly appearance In considering the treatment care must be taken to prevent suppuration. I have obtained the best results by exhausting the cyst with a subcutaneous syringe, and then injecting a dilute solution of iodine (tinct. iodi 1 part, water 2 parts). This solution should be removed by the syringe after it has remained in the cyst a few minutes.

Papilloma.—Occasionally we meet with a small warty growth on the auricle. This growth bleeds on the

slightest injury and should be freely removed and the surrounding surface cauterised, as otherwise there is a great tendency to recurrence, or it may even take on an epitheliomatous character.

Carcinoma.—The auricle is very rarely the seat of carcinoma, but when it does occur it is in the form of epithelioma, and differs in no way from epithelioma in other parts of the body. Complete and free removal should be promptly adopted, unless it has so far advanced that it has involved the deeper tissues and glands.

CHAPTER IV.

EXTERNAL AUDITORY MEATUS—MALFORMATIONS, INJURIES, OBSTRUCTIONS AND DISEASES.

Malformations.

Congenital malformations are due either to abnormal development or to adhesions following intra-uterine inflammation.

Imperforate meatus.—The meatus may be partially or completely obliterated; this condition is usually associated with malformation of the auricle. Occasionally there is a difficulty in finding the meatus, but even in the worst cases some kind of *cul de sac* will generally be found. The occlusion is sometimes osseous as well as fleshy. The amount of hearing in these cases differs considerably, but in all there must be a certain deficiency; now and again we meet with patients who can hear moderately loud conversation, but frequently the ear so affected is quite useless.

Treatment.—If the condition is only found on one side no interference is advisable, but should both ears be affected it may then become a case for operation. Even here, however, this should only be done if there is already a considerable amount of hearing power, for if there is an occlusion of the bone as well as of the soft parts no operation can possibly be of use.

Method of Operating.—The patient having been placed under the influence of an anæsthetic, the surgeon should make a crucial incision through the soft tissues obstruct-

ing the meatus; a small ivory or silver meatus tube with the usual shield (fig. 21) must then be inserted to prevent the surfaces from uniting again.

Although this operation may appear at first sight to be a very simple one, I should never recommend its being performed except in the most favourable cases, because there is always a great tendency to granulate up and heal across, and thus cause a return to the former state.

Collapse of the meatus.—This condition, partial or complete, used to be very commonly met with in elderly women who had been in the habit of wearing their bonnet and cap tightly drawn over their ears. Partial collapse of the meatus favours the accumulation of cerumen, and this assists in producing deafness. Complete collapse is in itself a cause of deafness.

FIG. 21.—Meatus tube.

I have also met with another cause of collapse; namely, a hypertrophic condition of the connective tissue about the auricle, similar to that which is seen in myxœdema.

The *treatment* consists in making the patient wear a meatus tube (fig. 21) so as to keep the canal open. This tube is made of silver, vulcanite, or other material about $\frac{5}{8}$ inch long with a shell-shaped shield at one end to prevent its slipping too far into the meatus. As a rule this tube should not at first be worn more than two or three hours a day lest it set up inflammation, but as soon as the ear is able to tolerate it, the tube should be

left in the whole day but removed at night. By the use of this tube in complete collapse the patient may at once regain perfect hearing ower, and after it has been worn some time the meatus will generally have become so patent that its further use may be dispensed with.

The report of such successful results, combined with the small size of the tube, makes a large number of deaf patients anxious to try it, although they themselves may not have the meatus at all collapsed. Many unscrupulous vendors encourage them in this desire, and in fact, I believe far more of these tubes are sold to people to whom they can be of no service whatever, than to those who really need their aid.

Injuries.

Occasionally the meatus is injured by the introduction of sharp pointed instruments, such as hair-pins, &c., either by the patient himself or by some officious friend, for the purpose of removing wax or other irritation or supposed obstruction. Again, injuries are at times produced by surgeons while attempting to remove foreign bodies by means of forceps, probes, &c. Very occasionally bullet wounds are met with in this region, but then the injury to the meatus counts for very little in presence of the far more serious mischief to the cranium and its contents.

Treatment.—As a rule it is only necessary to allay the inflammation and so allow the wounded surfaces to heal.

Obstructions.

The meatus may be obstructed by accumulations, or by foreign bodies. That which results from inflammation, &c., will be treated of later.

Accumulations.—These are of very common occurrence, and consist either of cerumen, epidermic scales, hairs, or inspissated pus; or of two or more of these mixed together.

Accumulations are perhaps most frequently composed of cerumen and epidermis together, forming a more or less compact plug. Sometimes there is only a small proportion of epidermis, while at others the plug is mainly composed of layer upon layer of it, the laminated mass having a pearly-white appearance. Occasionally the small hairs from the tragus form a considerable part of the accumulation. Again, at times an accumulation occurs towards the termination of a case of chronic otorrhœa, consisting partially of old inspissated and dried pus; in many of these cases the formation of the plug actually assists in curing the otorrhœa.

The causes of these accumulations, except in the last mentioned, are not fully understood. Exposure to cold, or any of the diseases which produce desquamation; alteration in the quality of the cerumen secreted; change in the configuration of the meatus; all these undoubtedly favour or are the direct causes of accumulations. But in by far the larger number of instances they would appear to be due to a bad habit, if I may say so, of over secretion of the cerumen and of desquamation of the epidermis. Dr. Guye (Amsterdam), however, maintains that in these cases there is actually a

diminution in the quantity of the cerumen secreted, but that the secretion is altered in character, so that it is not readily removed in the natural way by the movement of the jaw, and thus it accumulates.

If this accumulation occurs at or after middle life it is liable to recur again and again, so that the obstruction has to be removed every two or three years or possibly much oftener.

Diagnosis.—As a rule the patient gives a history of recent very marked deafness, coming on suddenly, often worse after lying down and better after getting up, this improvement being preceded by a sensation of cracking. On examining with the speculum the tube will be found to be filled, more or less completely, with cerumen, the colour of which varies from a shiny black to a pale brown. Here perhaps I should again caution the student that this examination requires some care, for if the speculum be not properly directed, one is liable to mistake a piece of wax lying on the floor of the meatus for a complete obstruction.

Generally the diagnosis is easy; but occasionally a small layer of cerumen lying on the membrane (called sometimes a *face plug*) may be difficult to make out, either on account of its blackness absorbing the light, or because its shiny appearance renders it liable to be mistaken for the membrane itself. In the first of these cases a change of light, such as from daylight to artificial (electric light is the best) will clear up the difficulty; and in the second, in addition to this, careful search should be made for the handle of the malleus, if that can be discerned, the object in view is undoubtedly the membrana tympani; while, on the other hand, if the end of a probe be carefully covered with cotton-wool, moistened, and then introduced very gently into

the meatus, the presence of cerumen is at once established by the discoloration which will appear on the tip of this little mop when it is withdrawn.

Another deceptive appearance may be produced by a thin layer of dry cerumen stretched across the meatus, producing what is called a *false membrane*. This frequently has a small opening in it which may readily be mistaken for a perforation of the membrana tympani. To make certain we should examine its position, note whether it is too near the opening of the meatus, and look out for the handle of the malleus. Again, with a mop of cotton wool, or by syringing, we can readily break it up if it be a false membrane, and then the true membrana tympani will be revealed some distance beyond.

Treatment.—Removal by syringing is the proper treatment. If, however, the plug is very hard, it should be softened beforehand by means of warm instillations of plain water, of oil containing a little thymol or carbolic acid, or of glycerine and water, and of course whenever suppuration is known or suspected to exist, an antiseptic solution should be preferred (Appendix). Undiluted glycerine should not be used, because it occasionally produces inflammation. The installation should be used twice a day for three or four days before the syringing. By softening the plug, the operation is rendered far more easy to the surgeon and much less disagreeable to the patient.

The softening is still more important where inflammation has been set up, and in such cases it is well to reduce the inflammation by means of counter-irritation, &c., before syringing is attempted.

Form of Syringe.—I prefer a two-ounce brass syringe for this purpose. The nozzle must be fine, but it is well

to have a rounded tip so as to diminish the risk of injury to the meatus (fig. 22). Most ear syringes have very bad nozzles, which are much too large, thus blocking up the meatus to such a degree that the return current is obstructed.

Mode of Syringing.—Having quite filled the syringe (without allowing any air to enter) with pleasantly warm water, or water to which an antiseptic has been added whenever suppuration is suspected, and having placed

FIG. 22.—Nozzle of Ear Syringe.

a small basin under the ear, the surgeon should straighten the meatus, drawing the ear outwards with a little twist. The fine jet of water from the syringe should then be directed so as to pass between the wall of the meatus and the plug, and *not* in the direct central axis. By this means, the water strips the plug from the meatus and the return current drives it out. The syringe may have to be used several times before the plug is detached, and the surgeon should not be content

with syringing only at one spot but should work right round the obstruction.

The best form of basin is made of glass, with a partition across it, so that when held under the ear, the further side can be filled with clean water for the syringe, while the other will catch the return flow as it comes from the meatus. A similar basin may be made in tin and answers equally well; but failing these, the bottom of a soap dish makes a good substitute as far as catching the water is concerned, while a second basin may be used for the clean water.

In syringing, the amount of force applied must be regulated by the amount of obstruction, and after this has been removed, care should be taken that no force is used lest the membrana tympani be injured.

When the water comes out quite clean the surgeon may conclude that the whole of the obstruction has been removed, or if the end of the expelled plug displays the cast of the membrane, that will indicate the same thing. It is not wise, however, to wait for these indications, but the operation should be suspended and the ear examined from time to time.

If the syringing gives rise to pain or tenderness before the obstruction is removed, it is best to desist immediately and continue the softening process for a few days longer. Otherwise inflammation in the ear may be set up, and this will be increased by the plug acting as a foreign body.

After the removal of the plug and when the ear has been carefully dried, a small piece of cotton-wool should be inserted and kept in for a few hours to prevent cold.

Sometimes the syringing will produce giddiness from disturbance of the semi-circular canals; or again it

may produce fainting even when no pain has been felt. These two disagreeable results may, however, be generally avoided by previously softening the plug.

It is well to warn patients that during the softening process, the swelling of the plug and presence of the fluid may make them temporarily deafer; otherwise, finding that the treatment is apparently making them worse, they lose confidence and refuse to come again to have the plug removed.

Before dismissing the subject of syringing, I would urge upon my readers the necessity of learning the knack of doing it properly, an art which requires much practice; for occasionally a plug cannot be removed without the greatest possible dexterity.

The use of other Instruments.—When the plug consists chiefly of cerumen no other instrument than the syringe should be used; but when the obstruction is made up entirely or almost entirely of epidermic layers, the syringe will frequently fail to remove the mass without the assistance of other instruments.

In such cases a flattened (not sharpened) probe and a pair of fine forceps may be used. But these two must never be employed without thorough illumination of the meatus, so that the surgeon is able to see everything he is doing, and even then extreme care is required. In fact for the removal of the laminated masses several sittings are sometimes necessary.

I may here mention that occasionally we meet with a localised patch of chronic dermatitis with desquamation, when the surface becomes covered with epidermic layers. Should the patch be situated on the membrana tympani it is liable to produce very distressing tinnitus; moreover the condition may extend into the middle ear, through a perforation in the membrane, giving rise to *what is known* as Cholesteatoma (p. 201).

In these cases of localised dermatitis affecting the meatus, it is not only necessary to remove the scales, but also to stop further desquamation. This is sometimes a difficult matter, but may usually be accomplished by painting the denuded surface, from time to time, with a solution of nitrate of silver (gr. xxx. to ℥ j.), or with diluted nitrate of mercury ointment (Appendix).

Sometimes, after an obstuction has been removed, the patient asks for advice as to how the ears should be cleansed, thinking, as many do, that the presence of this accumulation indicates want of cleanliness. The surgeon should explain that such is not the case, and that the ears should never be cleaned out further than can be reached by the finger covered with a towel, and that all aurilaves and ear-cleaners are worse than useless. In fact the surgeon will often see from the polish on the surface of the plug, that the patient has hastened his deafness by pushing the cerumen on to the drum by some such means.

Occasionally, as already stated, we have a plug complicated with inflammation of the meatus. Sometimes the plug, acting as a foreign body, produces so much irritation that inflammatory polypi are formed in front of it, and hide it completely. Again, the swelling of the meatus itself is often sufficient to obstruct the view. These cases are liable to puzzle the surgeon and lead him to a very erroneous diagnosis and prognosis.

The inflammation and polypi should be treated as laid down later on, and as soon as the former has quite subsided, the plug must be removed, taking care not to attempt this until it is quite soft.

Foreign bodies.—A great variety of foreign bodies have been found from time to time in the meatus.

For practical purposes they may be divided into three classes:—

1. Those that are liable to swell and enlarge, thus becoming firmly impacted and the source of serious irritation; such as peas, beans, seeds of the locust bean, coffee berries, etc.

All these are apt to swell and even germinate under the influence of the warmth and moisture around them, and to set up inflammation which may extend through the upper wall of the meatus to the meninges of the brain, and result in fatal meningitis even without perforation of the membrana tympani.

2. Those foreign bodies that are liable to irritate but which do not enlarge to any extent; such as some insects, pieces of cotton wool becoming putrescent from pre-existing discharge, etc.

3. Foreign bodies which do not enlarge and which in themselves are not liable to irritate; such as beads, shells, cherry stones, slate pencil, small pieces of wood, etc.

A foreign body may remain in the ear without producing any distressing symptoms for years; but those belonging to Classes 1 and 2—especially Class 1—are very liable to produce or aggravate inflammation. Those in Class 3 are less likely to do so; and indeed, they often remain in the ear without producing any serious effect for a very long time. I once removed a cherry stone quite easily by syringing it from the ear of a man of sixty, who assured me that it had been in since he was five years of age, his parents having objected to have it touched, because a surgeon, in attempting to remove it with instruments, had pushed it further in. It had never caused him any trouble.

Foreign bodies are more frequently found in the ears

of children than in adults; they are generally pushed in while playing, or while trying conjuring tricks, such as pretending to pass objects from ear to ear.

Diagnosis.—As a rule this is sufficiently easy, the speculum and a good light revealing the presence or absence of a foreign body. But it must not be forgotten that many patients, especially elderly persons, mistake a form of tinnitus for the presence of an insect or other foreign body.

Sometimes the obstruction is so covered in cerumen that its nature cannot be made out until after removal. Again, not unfrequently, the inflammation has caused so much swelling as to hide the substance. Or the irritation may produce a fringe of inflammatory polypi which hides the foreign body. In these cases the diagnosis may be difficult until the inflammation has been reduced.

Treatment.—There are very few cases in surgery in which the operator is more likely to be led astray than when trying to remove foreign bodies from the meatus. The temptation to use the probe, scoop, or forceps is almost too great to be resisted; and yet, if these are used (as they generally are) without perfect illumination, the meatus is almost certain to be injured and inflamed, while the foreign body may be only driven further in. A few years ago a case of this kind occurred where so much injury was done that the patient died of the meningitis which ensued.

In ninety-nine cases out of a hundred a foreign body if detected early, can be removed by syringing unless it has become impacted by swelling, and this rarely occurs at first. But this syringing may require considerable skill. The meatus must first be straightened by traction of the auricle (page 70), and then the stream of

warm water should be directed between the wall and the foreign body, so as to pass behind it. The obstruction will then be driven out with the return current. If the surgeon does not succeed directly and there is no inflammation, he should desist and make another attempt later on. Should there be cerumen gluing it in, as it were, this must be softened by means of glycerine and water or carbolized oil. But if this is the case and it belongs to Class 1 of foreign bodies, the risk of swelling must also be taken into account.

In difficult cases and especially in nervous children the operation of syringing is much facilitated by placing the patient under the influence of an anæsthetic.

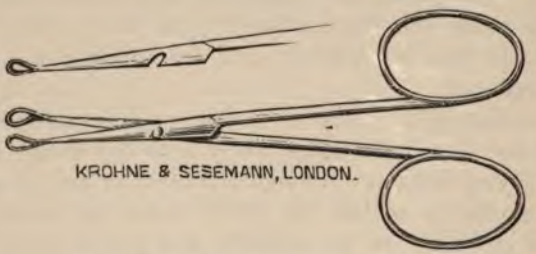

FIG. 23.—Guye's forceps with separable blades.

But suppose all attempts at removal by syringing have failed, what is to be done? Most emphatically do I answer, "Then let none but an experienced surgeon undertake its removal." The method should be as follows:—The meatus being well illuminated must be first carefully examined. If the foreign body is found adhering by means of coagulated blood, etc., to one side, it must be loosened by using a flattened probe as a lever, and then it may be syringed out. If, however, it is impacted by the swelling either of its own substance

or of the walls of the meatus, other means must be adopted. Many ingenious forms of forceps, etc., have been devised; Dr Guye's, which are like miniature obstetric forceps, are perhaps the most useful (fig. 23). Sharp pointed hooks of various forms are recommended, but I consider them all too dangerous for use, remembering, as we must, that the meatus is not a tube which can be pulled about with impunity. When the foreign body has reached the outer part of the meatus and has there become somewhat fixed, simple blunt hooks are often of use, or a loop of thin wire may be carefully hitched over it; a very good and ingenious device too under these circumstances, is to dip the end of a wooden match into liquid glue, and keep it gently in contact with the foreign body until set, when both match and foreign body may be easily withdrawn.

Another very valuable instrument is an ingenious little blunt hook devised by Sir Joseph Lister. The shape is seen in fig. 24. It will be noted that the rectangular hook is flattened and curved from side to side, so as to adapt itself to the curvature of the meatus, and pass readily between it and the foreign body. In cases where this hook is to be used the patient should be put under an anæsthetic. The instrument should then be introduced with the convexity of its hook towards the posterior wall of the meatus, care being taken that as good an illumination as possible is kept up. When the foreign body is reached, the instrument should be insinuated between it and the posterior wall of the meatus, the surgeon pressing rather more against the wall of the meatus than on the body, so as to avoid pushing it further in. As soon as he has passed it, (which may be ascertained by gently rotating the hook), the hook is to be turned about 40°, and in this position

it is now of course behind the obstruction. Traction must then necessarily bring out the foreign body; or, as sometimes happens, it will be cut in two, and then it may be readily syringed out. Care should be taken to prevent bleeding as much as possible, both because this will immediately obscure the view, and because it indicates more or less laceration of the meatus.

Although I consider Lister's hook a most valuable instrument in practised hands, it is at the same time a very dangerous weapon if not used with the utmost care.

When a fringe of inflammatory polypi has grown in front of the obstruction it is generally necessary to remove them before commencing to remove the foreign

FIG. 24.—Lister's hook.

body; after this the ear should be syringed out with dilute perchloride of iron, to clear away the blood and arrest further bleeding.

Many other ingenious methods have been devised for extracting foreign bodies, but I cannot refrain from again insisting that the surgeon should use none of them until syringing has had a fair trial; and that whatever means are employed, the utmost care and delicacy of touch are absolutely needful.

There is one little exception to the universal rule of syringing, and that is in cases of impacted wool. Here, with good illumination, the forceps may be used, and on account of the clinging nature of the substance it is very readily removed.

Diseases.

Inflammation of the Meatus.—This may be divided into *circumscribed* and *diffuse*.

Circumscribed inflammation or furunculosis is a very common disease affecting the cartilaginous portion of the meatus.

Cause.—Except when they result from diabetes, change of diet, debility or such like, it is not known with accuracy what are the causes which predispose to the production of boils in the meatus, but the exciting causes which favour their development in other parts of the body act in the same way with regard to the meatus; as for instance where the latter is bathed in the purulent discharge from suppuration of the middle ear. Dr. Lœwenberg, of Paris, has, however, thrown some light on the subject by having discovered certain minute organisms in the contents of the boil, which no doubt will account for the great tendency there is to recurrence; according to this observer the sebaceous glands, into which the organisms have found their way, form the seat of the disease.

Symptoms and Course.—As a rule there is intense pain, sufficient to keep the patient awake at night. But the degree of pain depends not only upon the amount of inflammation, but also upon its site, for when very superficial there is little or even none. If, however, it is deep-seated, and especially if the fissures of Santorinus become involved, the pain is extreme; the reason being that in these situations the tissues are very rigid, and free swelling being interfered with the nerve-endings are subjected to greater pressure.

When the swelling is very great, the meatus becomes blocked and gives rise to a considerable amount of

deafness, which generally passes away as soon as the swelling is reduced sufficiently to allow a free passage along the meatus. Should, however, the deafness remain after the swelling has gone down, it may be found to result from accumulations of discharge, epidermic scales, &c., lying on the membrana tympani, and these accumulations must of course be duly syringed away.

On examining the ear one or more swellings are usually noticed protruding into the meatus; but if, as frequently happens, these are of small size, they may easily be overlooked until the pain produced by the pressure of the speculum calls attention to them. Their most common position is on the floor of the meatus close to its entrance.

Sometimes the swelling is so prominent as to be mistaken at first sight for a polypus; but it may be readily diagnosed from this by its broad base, which is easily recognised if the surgeon attempt to pass a probe round it.

After a few days, pointing and rupture, or sometimes resolution or still more frequently semi-resolution, take place and the swelling wholly or partiall disappears; in the last case, only to return again after a short time.

When the furunculus ruptures, there is, of course, a slight discharge in the meatus, then the swelling disappears and the patient recovers. The condition, however, is very apt to return, and a patient may have three or four attacks following each other at intervals of perhaps a fortnight.

Treatment.—Early incision so as to deplete the part, even if pus has not already been formed, gives great relief and may arrest the disease. Counter-irritation in the form of a blister behind the ear also gives relief and tends to reduce the inflammatory swelling; while, if the

pain is very severe, a couple of leeches should be applied in front of the tragus. Carbolized poultices and hot fomentations are of great service, but these must not be continued after the pain has disappeared; when poultices are used they should be small and encased in gauze so that they may be removed entire. As soon as the discharge makes its appearance, warm injections containing a little carbolic acid or other antiseptic, are advisable.

Again, if there is considerable discharge, with pain, a warm lead and morphia injection (liq. plumb. and liq. morph. āā ℥ ss., water ℥x., one tablespoonful to a wineglass of warm water) will be serviceable.

When all the acute symptoms have gone and the swelling has nearly disappeared, means for the prevention of a return should be employed; and for this purpose I make use of some dilute mercurial ointment, as for instance (ung. hyd. nit. ʒj., ol. amygd. ℥j.). This is to be painted into the ear with a camel's hair brush two or three times a day, are being taken to line the whole of the cartilaginous portion of the meatus with the ointment. This treatment, whether by causing absorption or by destroying Lœwenburg's organisms, will in most cases prevent a return, but it should be persisted in for some three or four weeks.

The patient's general health must not be overlooked; tonics, etc., often being required.

It is well to warn the patient of the tendency to recurrence of the disease; otherwise should it return he may consider that the surgeon has not properly treated the case.

Diffuse Inflammation, Acute and Chronic.

Acute.—The most frequent cause of this condition is bathing, the cold water getting into the meatus and setting up inflammation. Sea-bathing is especially liable to produce it, on account of the waves. Wounds and foreign bodies also induce this condition.

Symptoms and Signs.—Pain in the meatus, varying considerably in amount, and tenderness on pressure over the tragus. Discharge generally appears sooner or later. On examining the meatus considerable swelling of the walls will be noticed, and this is more frequently found affecting the osseous than the cartilaginous portion. Deafness, varying in degree according to the amount of swelling and discharge, and the consequent interference of the membrana tympani.

In severe cases the tympanic cavity is involved, and perforation of the membrane takes place, this complication being indicated by the signs of perforation and by tenderness on deep pressure under the auricle. But, as a rule, it is unnecessary and very unwise to meddle too much with the meatus for the purpose of making a full examination.

On account of the intimate connection of the skin and periosteum in the osseous meatus, acute inflammation of this part is very likely to be complicated with acute periostitis and ostitis, which is indicated by polypoid granulations growing from the inflamed spot; and should this inflammatory condition extend inwards, meningitis may result. This is more likely to be the case when the bone forming the roof of the meatus is the part involved.

Treatment.—Counter-irritation in the form of blisters behind the ear, leeches in front of the tragus, hot fomentations, purgatives, and soothing injections or instillations form the most valuable modes of treatment. Injections, except soothing ones, should not be used; one of the most serviceable of these is the lead and morphia injection (page 81), but anything in the way of forcible syringing is to be avoided. Solutions of morphia (gr. ij. to ʒj.), of atropine (gr.j. to ʒj.), or of cocaine (10%) used quite warm, make good instillations (Appendix). If the pain prevents sleep hypnotics are advisable. When cerebral complications are threatening, absolute rest and quiet are indispensable.

After the more active symptoms have passed away insufflations of finely powdered boric acid may be employed; and if any polypoid granulations exist, they should be touched with nitrate of silver.

Acute inflammation is generally followed by a chronic stage of the disease.

The *prognosis*, as regards the hearing power, is usually good unless the tympanic cavity has been involved, and even then perfect recovery is frequently obtained.

Let me here mention that it is well to warn all persons liable to disease of the ear against bathing, especially in the sea, without some protection to the ears; the best safeguard is afforded by putting a large piece of cotton wool in both ears, and wearing an oilskin cap fitting tightly over them.

Chronic Inflammation.—Chronic inflammation of the meatus, or external otorrhœa, is usually a sequela of the acute form.

The signs and symptoms consist of a certain amount of deafness with purulent discharge. The absence of a perforation of the membrana tympani is sufficient to dis-

tinguish between this condition and chronic suppurative catarrh of the tympanum (p. 146).

Treatment.—This is the same as for simple cases of internal otorrhœa (p. 151), and consists of injections and insufflations.

The *prognosis* is favourable.

Eczema.—Acute and chronic.—*Acute eczema* of the meatus, and indeed of the concha, is very common in badly fed infants, especially during teething. In these cases there is generally a profuse watery discharge, not unfrequently tinged with blood, and this discharge, escaping on to the surrounding surfaces, sets up an eczematous condition.

As a rule, it is impossible to make sure that there is no perforation of the membrana tympani in these infantile cases; but wherever a diagnosis can be readily made without unduly irritating the parts, the surgeon should make one, following the rules on page 146.

The deafness is usually very marked because the surface of the membrana tympani is more or less involved in the general eczematous condition.

Treatment.—Attention to the proper feeding and to the general health is absolutely necessary. Mild injections, such as dilute liq. plumbi, may be used for cleansing the meatus, the surfaces of which should then be lightly painted with some ointment such as vaseline, ung. diachyli (Hebra's ointment), ung. zinci or ung. acid. borici (Appendix). All friction must be avoided and no soap allowed to touch the parts affected.

In inveterate cases ulceration of the skin may take place, and then the following treatment is advisable. After thoroughly cleansing with a warm water injection, the surfaces should be painted with a strong solution (ʒj. to ʒj.) of nitrate of silver, and then covered with

boric acid ointment. This caustic application may be required two or three times at intervals of twenty-four or forty-eight hours.

Acute eczema, when it does occur in the adult, has to be treated locally in the same manner, and any predisposing constitutional cause must as far as possible be removed by appropriate internal remedies, alteration of diet, etc. Attention may be drawn in this connection to the eczema of the meatus which occasionally follows the use of alcoholic instillations in chronic otorrhœa (p. 152).

Chronic eczema.—This is a condition that is more frequently found in adults than in children. The meatus presents a somewhat swollen, or it may be a very much swollen appearance, with a more or less glazed and cracking surface, and frequently the auricle is also involved. The ear is often so irritable that the patient cannot refrain from rubbing it. There is a slight watery discharge, and the deeper portion of the meatus is often filled with débris of the desquamation. The hearing will not be affected unless the swelling or the débris is sufficient to block the meatus or cover the membrana tympani.

Treatment.—Unless the case is severe and of long standing, suitable injections and ointments are generally sufficient to effect a cure in a week or two, but in some instances there is a great tendency to return. Ointments of a stimulating nature are preferable, and of these I consider some form of mercurial application to be the best; diluted nitrate of mercury ointment (p. 81), is very good; occasionally some form of tar ointment is still better. These must be lightly applied with a camel's hair brush so as to avoid any rubbing, and the surfaces must be kept constantly moist by using the application three or four times a day.

Warm injections of boric acid or sulphate of zinc may be used from time to time, for the removal of scales and débris; but, with these exceptions, as little washing and friction as possible is to be employed, and the use of soap is especially to be avoided.

When the case is severe or of long standing, with much thickening of the integuments, then constitutional treatment becomes necessary. Arsenic in the form of Fowler's solution (mv. three times a day, after food), should be tried, as it generally yields very satisfactory results. Of course care must be taken that no arsenical irritation is produced, and in those cases where ordinary doses are not tolerated, minute ones will be found to act very beneficially. Both in the acute and chronic forms of eczema the patient should be advised not to wear cotton wool, as it is liable to adhere to the inflamed surfaces and cause pain and bleeding on removal.

Otomycosis.

Occasionally the meatus is the seat of inflammation due to the presence of microscopic fungi. Several forms of these have been described, but the chief among them are the aspergillus fumigatus, aspergillus niger, and aspergillus flavus.

In the United States and in Germany, the occurrence of fungi in the external meatus is of tolerable frequency; thus Bürkner, Knapp, and Grüber detected their presence about once in every thousand cases of ear disease examined; Schwartze once in every 625; Burckhardt-Merian 1 in 333; Roosa 1 in 250 and Bezold as often as

1 in 100.* In my own experience, limited of course to England, the condition has not existed in any larger proportion than once in 3000 or 4000 cases.

The exact etiology of otomycosis is obscure; from the above it would seem that much depends upon locality, for the appearances presented are so exceedingly typical, that it is hardly possible that the disease could be overlooked. Siebenmann† lays considerable stress upon the influence of oily instillations in favouring the development of otomycosis, but in England at any rate, no custom is more common amongst the laity, and yet the existence of the disease in this country is a great rarity.

Symptoms and Diagnosis.—The symptoms depend greatly upon the length of time which the disease has lasted, and the amount of inflammation which may happen to have been excited.

In early stages, marked deafness, a sense of fulness in the ears and possibly some tinnitus are all that are complained of.

In more advanced cases, itching of the meatus, slight shooting pains in the ear or even severe pain may ensue; in fact we may have all the usual subjective symptoms of a very acute inflammation.

On examining the meatus with a speculum, the canal will be found to be wholly or partly occluded by layers of desquamating epidermis, which, on removal, look like damp blotting paper studded (in cases of aspergillus fumigatus or aspergillus niger) with dark spots. This appearance is so characteristic that there is usually no difficulty as to the diagnosis, but our naked eye

* Bürkner. Contributions to the Statistics of Ear Disease, *Arch. f. Ohrenheilk.*, vol. xx., p. 2.

† *Archives of Otology*, vol. xviii., p. 269.

observations may be confirmed by placing a little of the débris under the microscope. We shall then see that in addition to numerous epithelial scales of the ordinary squamous variety, the mass consists of a thick network of mycelium (fig. 25), with numerous fruit-stalks terminating in the usual rounded fructifications; these latter are comparatively large ($\frac{1}{50}$ in. diam.) and intensely black in colour in cases of aspergillus niger; small ($\frac{1}{250}$ to $\frac{1}{500}$ in. diam.), and smoky or sooty in appearance in cases of aspergillus fumigatus, small and yellow in aspergillus flavus.

FIG. 25.—Aspergillus Fumigatus from one of the author's preparations x 300 diam. 1. Mycelium. 2. Hypha. 3. Fructification. 4. Spores.

Treatment.—Simply syringing out the ear, even if one of the ordinary antiseptic solutions be employed, will not, in itself, suffice to eradicate the disease, for although the obstruction may be removed, it is nearly impossible to wash every microscopic spore out of the meatus by this means, and unless these spores are either destroyed or removed recurrence of the fungus is almost certain.

In the first place, if acute inflammation is present we must take some pains to subdue it; for which purpose we may apply blisters behind the ear, leeches, &c., and at the same time cleanse the meatus by means of the

syringe, using warm boric or weak sublimate solutions followed by instillations of oil containing ung. hydrarg. nit. (p. 81).

The inflammation having subsided, or the meatus having been cleared out if no inflammation exists, the next step is, to destroy *in situ* the remaining spores; for this purpose, after using the syringe, the patient is placed on a couch, lying with his affected ear uppermost, and the meatus is filled with absolute alcohol or with alcohol containing hydrag. perchlor. (1 in 500) which is allowed to remain in position for some ten or fifteen minutes, the process being repeated twice or thrice daily until the meatus appears to be quite healthy.

If these directions be carefully carried out, we may very safely predict that an absolute cure will ensue in a very short space of time, and we shall ourselves be spared the mortification of having to do our work over again, as is likely to happen if less stringent precautions be taken.

Gouty Inflammation.—Gouty patients are occasionally liable to inflammation of the meatus.

This should be treated as an ordinary case of inflammation together with constitutional treatment of the gout itself. Counter-irritation behind the ear, injections if there is a discharge, aperients containing colchicum, free use of diluents together with bicarbonate of potash, are in all such cases very serviceable.

Syphilitic Inflammation.—Syphilitic inflammation is very rare but it does sometimes occur, and then we may get a fringe of condylomata round the meatus.

It must be treated locally and constitutionally as when it occurs elsewhere. An injection of black wash is strongly to be recommended (Appendix).

Tumours.—Polypi growing from the walls of the

meatus are generally due to periosteal inflammation consequent upon caries, but occasionally we meet with true fibrous polypi. For treatment see p. 174.

Exostosis.

The late Dr. Cassells, of Glasgow, introduced a primary broad classification of the bony out-growths of the meatus. He divided such growths into hyperostoses and exostoses proper.

By hyperostosis we understand a diffuse enlargement of bony tissue, the result more particularly of chronic inflammation. This out-growth usually presents itself in the shape of a comparatively large but uniform swelling of one side of the osseous wall of the meatus. It increases in size slowly (though more rapidly than true exostoses), and its growth may cease at almost any point; but very frequently it extends until the meatus is completely blocked, when it occasionally causes pain from pressure on the adjacent surfaces.

The exostoses proper may be grouped under three chief heads, viz.:—

1. Multiple; uniformly smooth and rounded; pale and glistening on the surface; even denser than ivory in consistence.

The etiology of these formations is obscure. Bathing, syphilis, and many other causes have been assigned for their appearance, but, so far as my own observations go, I am inclined to belief that they are usually of gouty or perhaps rheumatic origin; more especially as they are seldom met with in hospital patients, but in the well-to-do and those suffering from a gouty diathesis.

Hence their occurrence varies a good deal with nationality, and hence also, perhaps, the reason why Englishmen are particularly prone to this disease. It must be admitted too, that frequent bathing seems to act as an exciting cause.

In size they may vary from that of a millet seed to that of a split pea. Their growth is extremely slow, and it is but seldom that the meatus is found completely occluded by them, for directly opposing exostoses come in contact with one another, their growth appears to be arrested. Thus a chink is always left which would be ample for ordinary hearing purposes, were it not frequently liable to become obstructed by the accumulation of débris (epidermic scales and cerumen), and hence it is that deafness is complained of.

2. Multiple; irregular in shape; of pale pinkish hue and dull appearance; with broad bases and of great density.

For the most part the origin of these may be traced directly to the irritative action of old standing otorrhœa, or even to the actual ossification of polypi. They increase in size but slowly, though probably their growth is rather more rapid than those of the first class, especially so long as the otorrhœa remains unchecked; and hence they may occasionally be met with completely occluding the meatus.

3. Single polypoid exostoses, consisting of a nucleus so to speak, of ivory-like consistence, from the surface of which trabeculæ of cancellated bone project into a layer of fibrous tissue, the whole being attached to the outer edge of the osseous meatus by a bony pedicle.

These are very rare and would seem almost invariably to be the result of ossification occurring in a fibrous or fibro-cartilaginous tumour. Their tendency to compara-

or pedicle, are easily removed by means of the dental elevator, or as suggested by Mr. Field, they may be broken off with a pair of dental stump-forceps.

By far the most useful method of removing aural exostoses, especially those of the first and second class is by means of a modified dental drill or burr (fig. 26) worked by some form of dental engine.

If a single growth has to be removed, the drill should be applied to it as far away from the base and as near the apex as possible. Commencing with a very fine drill, when once the head has buried itself in the growth, we may exchange it for one of a larger size

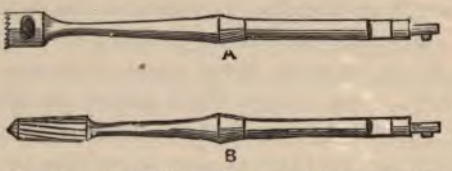

FIG. 26.—A. Trephine. B. Drill (medium) used for removal of exostoses—exact size.

until at length the action is simply that of a rotatory file working in a furrow or groove. In some cases, the juxtaposition of two or more exostoses in itself forms a groove, in which the drill may be inserted and the filing process commenced from the surface.

Instead of a solid burr, I frequently use a minute trephine, (fig. 26, A), similar to those occasionally used by dentists. It differs from the ordinary surgical trephine not only in respect to its size, but also in the absence of the central peg or tooth. Substituting this instrument for the burr in the dental engine, the method of using it is simply as follows, viz.:—As large a trephine as possible is selected, and it is applied as near the base as

will permit the circumference of the instrument to rotate freely above the apex of the growth, so that at any moment only a portion of the circumference of the trephine is in actual contact with the tumour; the object being to cut off a portion of the growth rather than to make a hole in it.

The cases in which this method is more distinctly applicable, are those where one growth is decidedly more prominent than the others, and these are precisely the cases in which we are most frequently called upon to operate. On the other hand, when the object is simply to enlarge a pre-existing, though narrow opening between several exostoses, the solid drill is to be preferred.

It will readily be understood that these operations are frequently very tedious, and more than one sitting may be called for. This is partly due to the blood which so quickly accumulates in the narrowed meatus, obstructing the view and necessitating the frequent removal of the drill, and partly to the density of the growth itself; on this latter account too, the burrs are particularly liable to slip or run off the surface of the tumour, and, in fact, until the head of the drill is well buried in the tissues, we can never be certain that this will not occur.

If these operations are performed with due antiseptic precautions the results are as a rule highly satisfactory. If, however, the wound becomes septic, granulations are apt to crop up at the edges of the injured surface, but even these yield to the simplest treatment. After removal of exostoses of the third variety, it will generally be found necessary, for the complete restoration of hearing, to syringe away a mass of epidermic scales, which will be found to have accumulated behind the growth. In this variety too, I have occasionally

observed that the pedicle arises from a cartilaginous surface; and this, to some extent at any rate, may account for the fact that they are exceedingly prone to recur, while the other bony outgrowths which I have described above, shew little or no tendency to this recurrence.*

* For further details see author's paper in *Archives of Otology*, vol. xx., p. 45, Jan. 1891.

CHAPTER V.

INJURIES AND DISEASES OF THE MIDDLE EAR.

Injuries.

Rupture of the membrana tympani may be produced in two ways; first, by directly wounding it with some more or less pointed instrument; second, by explosions.

Wounds.—Hair-pins, pencils, penholders, matches, spectacle arms, &c., pushed into the meatus may produce the wound. If the rupture is in the lower half of the membrane, the injury to the hearing may be exceedingly slight, and provided no inflammation is set up, the perforation will heal rapidly. In these cases a piece of cotton-wool should be kept in the meatus, and a strictly expectant treatment followed.

If the perforation is in the upper part of the membrane much injury may be done to the ossicles and their attachments, and considerable deafness will follow. These cases should be kept very quiet to avoid inflammation, and as healing proceeds, careful inflation by means of Politzer's bag is advisable. If there is any tendency to inflammation, a blister should be put behind the ear and a purgative administered. I often blow in finely powdered boric acid so as lightly to cover up the wound, and thus allow it to heal under the powder.

Syringing the ear should be always avoided unless a purulent discharge has already been set up.

If acute inflammation supervene, the case must be treated accordingly (p. 100).

Explosions, including atmospheric condensation produced by blows on the ear, will occasionally bring about rupture of the membrane; but more often these accidents merely produce displacement of the membrane and ossicles. In severe cases these injuries are complicated by concussion of the internal ear, when the consequent deafness may be chiefly the result of the latter injury. From my own experience I have come to the conclusion that blows on the ear and explosions (excepting from rapid explosives, as gun-cotton and nitro-glycerine compounds) rarely or never produce rupture of the membrane, or any serious displacement, unless there is some amount of Eustachian obstruction.

Rupture from these causes should be treated in the same way as that due to direct violence, but there is generally more need of inflation, and as a rule, the catarrh of Eustachian tubes and naso-pharynx requires attention. Simple displacement yields readily to gentle inflation, but concussion of the internal ear admits of no active treatment.

To prevent these accidents, artillerymen, riflemen and sportsmen should take care to keep their tympanic cavities duly inflated (*e.g.*, by Valsalva's method), and to block the meatus with a firm plug of cotton-wool. But I do not consider this at all necessary if the middle ears are quite normal.

Perhaps it will be well to notice here the rare accident of injury to the chorda tympani nerve in the tympanum. It is just possible that it may be accidentally injured when the membrane is ruptured by direct violence; but, as a rule, when this nerve is injured it is by the surgeon in the operation for division of the mem-

brane or in removing a polypus. When this accident occurs the patient perceives a slight pain, or it may be a metallic taste or a mere numbness, referred to the tip of the tongue and along the same side of it as the injured ear. The symptoms soon disappear and require no special treatment.

Diseases.

Catarrh.—The tympanic cavity and the Eustachian tube, being lined by mucous membrane, are subject to various forms of catarrhal inflammation. This catarrh in nearly every case commences in the naso-pharynx, and passes up the Eustachian tube into the tympanic cavity, sometimes involving the mastoid cells.

Middle ear catarrh is generally divided into the following:—

1. Acute non-suppurative catarrh.
2. Acute suppurative catarrh, or otitis media.
3. Chronic non-suppurative catarrh.
4. Chronic suppurative catarrh.

Acute non-suppurative catarrh, or otitis media without suppuration, is the usual cause of the ear-ache of infancy and childhood which is so frequently put down to mere neuralgia.

Symptoms.—Deep-seated pain with tenderness on deep pressure below the auricle; deafness, more or less marked; a sense of fulness; pulsating tinnitus, and throbbing; more or less fever.

Signs.—Vascular injection of the membrana tympani, especially along the handle of the malleus, and sometimes, though rarely, bulging of the membrana tympani; naso-pharyngeal catarrh.

In infants and very young children, of course the subjective symptoms are unobtainable, and we can only rely upon the objective signs, and to those enumerated may be added the constant sharp cry and the tendency to rub the affected ear.

Diagnosis.—This condition may be distinguished from mere neuralgia by the congestion of the membrana tympani, and by the loss of hearing power; and from the various forms of inflammation of the meatus, by the absence of their signs as recognised by the speculum, and also by the tenderness on deep pressure below the auricle. Lastly, in nearly every case there will be marked naso-pharyngeal catarrh.

Causes.—The predisposing causes are former suppurative inflammation; existing chronic suppurative catarrh; catarrh of the pharynx; adenoid vegetations.

Exciting causes.—Cold; fevers, especially those affecting the pharynx, as scarlet fever, measles, &c.; teething or other dental irritation; the nasal douche. This last must not be lost sight of when nasal injections are used; for, as pointed out by Dr. Roosa (New York), the fluid will occasionally enter the tympanic cavity and set up inflammation.

Treatment.—Injections of warm boric acid solution, or steam, or hot air injections where feasible; hot fomentations and hot bran bags; one, two or three leeches applied just in front of the tragus are very serviceable if the pain be acute; counter-irritation, such as a blister or strong mustard behind the ear.

And here it may be well to state that patients should be warned against the use of any direct irritation in the form of *stimulating* instillations, which only tend to aggravate the disease. Nothing is more common than to find them applying either some form of alcoholic instil-

lation, or pieces of roasted onion and the like; this is doubtless the result of a mistaken idea that the disease is neuralgic and not inflammatory.

Aperients are usually of great service, and should be given early in the attack. Diaphoretics are of some value, but their benefit is often over-rated. Soothing instillations of morphia, atropine, and cocaine (p. 83), will often give relief to the pain, but they must only be regarded as anodynes, and not as treatment of the disease itself. Occasionally, sedatives and hypnotics, such as antipyrin, chloral, opium, &c., are necessary to relieve pain and induce sleep.

Incision of the membrana tympani is strongly recommended by some authorities, but, as a rule, this is not called for unless there are signs (such as bulging of the membrana tympani) of suppuration within the tympanic cavity, when the case ceases to be one of the non-suppurative variety.

Lastly, the treatment of the naso-pharynx must not be overlooked, warm, mildly astringent gargles being usually necessary, and at times inhalations of warm steam are very beneficial. If adenoid growths are present of course they must be removed, but not before the acute otitis has thoroughly subsided.

These cases generally end in perfect recovery; but there is always a danger of adhesion of the membrana tympani to the inner wall of the tympanum, of adhesions fixing the ossicles, or of permanent occlusion of the Eustachian tube, any of which complications will necessarily produce considerable deafness. On this account, inflation by means of Politzer's bag should always be practised as soon as the more acute pain has passed off. Again, if the case is seen in its very earliest stage judicious Politzerisation may cut short the attack.

Acute suppurative catarrh or otitis media is only a further development of the foregoing condition, the symptoms being the same but intensified. The pain is more acute, but is generally relieved by rupture of the membrana tympani and consequent discharge of pus; this may occur within a few hours of the seizure, or, more frequently, after the pain has lasted two or three days. If the membrana tympani is examined before the rupture takes place a bulging and excessive congestion of the membrane may be noticed; if examined after, the meatus will be found filled with pus, and when this has been gently syringed away, pulsation of the pus filling up the perforation can almost invariably be detected.

The course of the disease is generally as follows:— The acute inflammation, which has extended from the pharynx, causes complete obstruction of the Eustachian tube, so that when suppuration takes place the pus, not being able to find an outlet into the pharynx, is imprisoned within the middle ear. Pressure is thus exerted on the membrana tympani, and bulging, ulceration, and finally rupture result.

The *causes* are the same as for the non-suppurative variety, but the exanthematous fevers tend much more to produce this suppurative form.

Although, for the sake of clearness of description, it is necessary to speak of inflammation of the tympanum as distinct from that of inflammation of the adjacent parts, and to distinguish between the suppurative and non-suppurative varieties, it must be borne in mind that in reality the disease is not confined within any such limits; and that, as a matter of fact, the cases which most frequently come before the surgeon are those where acute non-suppurative inflammation is followed by the acute suppurative, and in which not only the tympanum but

the meatus itself is involved. For example, the general aspect of the case is usually as follows:—

A patient complains of severe earache coming on after a bad cold and sore throat, and inability to sleep for two or three nights previously in consequence of the pain; also of much throbbing and tinnitus, a sense of great fulness in the ear and affected side of the face; marked deafness; a discharge appearing after a sense of rupture, and followed by a certain amount of relief from the pain.

On examining the patient there will be found a slight general swelling in the region of the ear, and considerable tenderness on pressure in front and below the auricle, or indeed upon any movement of the auricle or of the lower jaw; also profuse discharge from the meatus with partial occlusion from swelling of its walls. This swelling and tenderness entirely precludes the use of the speculum; for while it can do no good, as no view of the membrane is possible under such circumstances, its introduction would only increase and aggravate the pain and inflammation. An examination of the pharynx will show signs of acute catarrh either present or recently passed off, while increase in temperature and rapidity of pulse denote general febrile disturbance.

Treatment.—The treatment is the same as for the non-suppurative variety, but should be more energetic.

If the case be seen early enough, and there is no swelling of the meatus, puncture of the membrana tympani should be performed, especially if any bulging of the membrane is visible. This is done by means of a perforator such as shown in figure 27, and with the aid of a good light thrown on the membrana tympani so that the surgeon can see exactly what he is doing.

Moreover, the operation ought to be performed by a practised hand. The puncture should be made below and behind the handle of the malleus unless there is bulging in some other part, in which case that spot should be chosen for perforation.

FIG. 27.—Perforator for the membrana tympani. A. Broad view of point.

Leeches in front of the tragus in the acute stage will give great relief, and I always put a small blister behind the ear unless it is contra-indicated by the general exhaustion of the patient, as sometimes happens when this disease occurs in the course of scarlet fever, &c.

Wilde's incision.—In very acute cases, where leeches fail to relieve the pain, a vertical incision should be made on to the mastoid process, about an inch long and half an inch behind the auricle, care being taken to divide the periosteum. If the hæmorrhage is smart the relief will probably be great, for this incision acts by more directly depleting the inflamed part.

Prognosis.—This is not so favourable as in the non-suppurative variety, though far more so than is generally supposed, for an uncomplicated acute attack in the majority of cases terminates in complete recovery. But when this affection occurs in the course of scarlet fever, measles, &c., the prognosis is not nearly so good, for owing to the continued febrile condition there is greater destruction of tissue and more tendency to the formation of adhesions, &c.

Results.—Recovery, with complete or partial restoration of the hearing power; chronic suppurative catarrh; mastoid complications; periostitis and ostitis; necrosis and caries; meningitis; abscess in the brain; pyæmia. All these sequelæ will be treated of in due course.

Recurrent Acute Catarrh.

Patients, especially young children, suffering from chronic catarrh of the naso-pharynx, adenoid growths, &c., may be subject to recurrent attacks of acute catarrh, suppurative or non-suppurative.

Such cases should be treated during the attack as already indicated, but if nothing further is done the tendency to the recurrence will continue; it is therefore necessary to treat the chronic catarrh of the pharynx, Eustachian tube and tympanum, and when possible to remove any adenoid growths that may be present. When this is done the prognosis is very favorable.

Occasionally we get recurrent attacks of acute inflammation which are due to smouldering disease of the bony walls. Then repeated blistering together with attention to the general health will, as a rule, overcome the disease.

CHAPTER VI.

DISEASES OF THE MIDDLE EAR—(*continued*).

Chronic non-suppurative catarrh.—Chronic inflammation of the mucous membrane (usually termed catarrh), when affecting the middle ear is one of the most common causes of marked though not absolute deafness; practically of course it may be regarded as an extension of the catarrh from the naso-pharynx. Up to a certain point the disease is progressive, and becomes gradually less and less amenable to treatment as time goes on and the age of the patient increases, until at last a stationary condition of very decided deafness is reached. These advanced cases have long exercised the minds of aural surgeons; the most sanguine are ever devising new operations and new methods of treatment, but unfortunately it can hardly be said that the results up to the present are in any way commensurate with the ingenuity displayed. Of the numerous forms of chronic catarrh to which the naso-pharynx is subject, the following are the most important.

1. *The simple relaxed catarrh.*—Here the mucous membrane is more or less thickened, and of a dull leaden red colour; sometimes the swelling is greater and the colour brighter, and it is then called red catarrh.

2. *Dry catarrh.*—In this form the mucous membrane is drier than it should be, the patient often saying that he never uses a handkerchief, and that hearing is improved during the running stage of a cold. Sometimes

the mucous membrane is so dry that it presents a glazed appearance.

It would appear that whereas the former variety is more common in damp cold climates like our own, the dry catarrh is more prevalent in hot dry countries; hence it is often met with in the prairie districts of America.

3. *Granular catarrh.*—When this exists small elevations, in size and shape like the millet seed, are scattered over the mucous membrane, these elevations being usually of equal size. The small vessels leading to and from these elevations are seen to be greatly enlarged, giving the mucous membrane an injected appearance; this congestion produces catarrh, and some thickening of the mucous membrane. The granulations are mere hypertrophies of the normal adenoid tissue of the parts, or in other words, enlarged blood glands. Such a condition is very liable to produce Eustachian and tympanic catarrh by extending along the Eustachian tube.

4. *Catarrh due to growths.*—Including under this head the catarrh which arises in consequence of the presence of enlarged tonsils, adenoid growths, nasal polypi, hypertrophies, &c., of the mucous membrane of the nasal passages, and which will be considered in detail in a future chapter—(Chapter VII.).

Two or three of the foregoing varieties frequently exist in the same case. The simple and dry catarrh seem to belong more especially to adult and advanced age, while the adenoid form is characteristic of early life.

As the condition extends, the mucous membrane lining the tympanic cavity, including the various folds and coverings of the ossicles, becomes thickened, and adhesions are formed in various places; the due mobil-

ity of the ossicles is thus interfered with, and hence the marked deafness and also the difficulty in treatment. The most serious adhesions are those which Politzer has shown to occur* between the stapes and the sides of the bony pit in which it is contained (fig. 28).

All these inflammatory conditions may be hereditary, or, it might be more correct to say, may "run in fami-

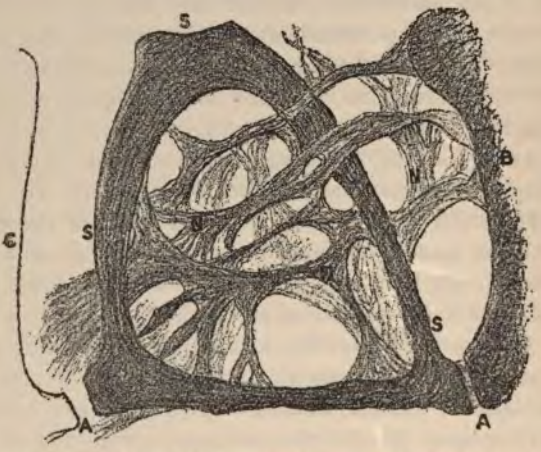

FIG. 28.—A section through the Stapes with fibrous bands fixing it in the bony pit; × 15 diam. (Politzer).*

A. Annular ligament of foot-plate of Stapes. B. Wall of bony pit. C. Outline of opposite wall. N. New bands of fibrous tissue. S. Stapes.

lies"; and this has been perhaps the chief cause of the old broad-sweeping assertion that "deafness is hereditary."

Symptoms.—Deafness, varying considerably from day to day, worse in damp and cold weather and especially on catching cold (except in the running stage of dry

* Comptes Rendus 4ième Congress d'Otologie, Brussels, 1888, p. 89.

catarrh, as already noted), with a marked tendency to increase as age advances. Even in the case of adenoid catarrh, where the masses diminish as the patient gets older, the deafness will tend to increase if much thickening of the tympanic mucous membrane has been produced.

When a chronic catarrh has existed for many years the deafness tends to become much more marked and the variations in hearing less frequent. When it reaches this stage, too, the patient begins to notice that he can hear better in a noise (see Chapter XIII.), such as when travelling in a train, omnibus, or other rattling vehicle. This peculiarity (paracusis Willisiana) is a very unfavourable sign.

Tinnitus, especially of a singing character or like the blowing off of steam, is a very frequent symptom, more particularly as the catarrh increases. In some instances it is absent throughout the whole course of the disease; whereas, in other cases, the tinnitus occurs so early, that it is perceived even before any loss of hearing has been noticed by the patient.

Again, as the patient chiefly hears his own voice through the medium of the skull bones (presuming that the internal ear is not affected), his voice sounds to him as if it had been produced in a box. This symptom, however, he does not notice when the disease comes on slowly.

Appearances.—On examining the meatus the observer is first struck by the absence of cerumen, and by the clean polished appearance of the whole surface of the meatus and membrana tympani. But this absence of cerumen although usual in advanced cases is not an invariable condition in this disease.

The membrana tympani being too concave, we find

that the cone of light has either been replaced by a rounded bright spot or that it has disappeared altogether. The upper end of the malleus and also the short process project very markedly, while the folds of the membrane radiating from the short process are much exaggerated. On each side of the projection the membrane forms a deep sulcus. The membrane itself may be almost normal in appearance, but as a rule it has lost its lustre, and often presents considerable opacity; sometimes, too, it may exhibit crescentic areas of semi-calcareous deposit, or may even have become atrophied. The extreme retraction or depression of the membrana tympani is due to loss of air within the tympanic cavity, caused by constant absorption through its moist walls, and failure of the usual fresh supply through the Eustachian tube, the latter being blocked up with swollen mucous membrane; and so the external atmospheric pressure drives in the membrana tympani, it being no longer supported by an atmosphere of equal pressure within the tympanum.

On inflating the tympanum by Politzer's bag or other means, the membrana tympani will be more or less restored to its original position. If the disease has been of long standing, and the membrane and ossicles have, in consequence, become more or less fixed by thickenings and adhesions, the restoration will be very slight and the improvement to the hearing power equally small. On the other hand, in recent cases, especially in children, inflation may produce a very material improvement both in the position of the membrane and in the hearing power. Siegle's pneumatic speculum (p. 32) may be most advantageously used for the purpose of ascertaining the amount of mobility of the membrane.

On examining the pharynx some form of catarrh, already described, will be seen.

Diagnosis.—The appearances already noted and the effect of inflation are sufficient to make the diagnosis easy. But it is always advisable to test the patient by means of the tuning fork (p. 53), in order to ascertain whether there is any internal ear complication.

Treatment.

The objects to be striven for are:—

1. To reduce the catarrh.
2. To obtain free ventilation of the tympanum.
3. To restore the membrana tympani, &c., to the normal position.

Reduction of Catarrh.—For this purpose applications to the naso-pharynx may be made by *nasal injections* of one of the following in warm solution; common salt, chloride of ammonium, borax, chlorate of potash, bicarbonate of soda, or sometimes stronger astringents, such as tannin (see Appendix).

Gargles of stronger solutions of chlorate of potash, borax, alum, tannin, &c., are sometimes very valuable. While gargling, the patient should either sit with his head thrown well back, or lie down flat so that the fluid may reach the naso-pharynx.

Paints.—Tannin, in the form of the glycerinum acidi tannici, is a very useful application where there is much relaxation and thickening, and may be used when the patient is unable to gargle. Or solutions of perchloride of iron in glycerine, and sometimes solutions of nitrate of silver (gr. xx. to the ounce), may be used with advantage. In cases of adenoid catarrh I occasionally make use of a

five to ten per cent. solution of chromic acid. For applying these paints a large slightly bent throat brush should be employed, care being taken that it passes well up on each side towards the Eustachian tube.

The foregoing applications to the naso-pharynx affect the mouth of the Eustachian tube; but besides this, some further means must be adopted if we desire to treat the tube and the tympanic cavity generally.

Vapours may be introduced into the tympanum through the Eustachian tube, either by means of the catheter

FIG. 29.—Basdon's inhaler.

(which is the most perfect method), or by making the patient perform Valsalva's inflation (p. 43), when the naso-pharynx is filled with the vapour. As a rule I adopt the latter method because, after the patient has learnt it, he can repeat the operation as often as may be desired, whereas if the inflation has to depend on the surgeon it cannot be done so frequently.

Many kinds of vapours are used; I prefer the chloride of ammonium fumes as produced in one of Basdon's *(fig. 29)*, Kerr's or Hawksley's inhalers. These inhala-

tions are especially useful in dry catarrhs, and in moist catarrhs where there is not much thickening of the mucous membrane. Pine oil, eucalyptol, &c., may be added to these inhalers if necessary. Again, hot inhalations of tincture of benzoin, pine oil, &c., are sometimes of service, and may be obtained by using an ordinary earthenware inhaler.

The vapour of iodine combined with ether or chloroform may be advantageously used in some very chronic catarrhal affections of the tympanum (one part of ether or chloroform to three of tincture of iodine); of this forty minims should be put into the bottom of an earthenware inhaler and then half a pint of boiling water poured upon it (Appendix). The hot vapour must then be drawn into the mouth (not into the chest) and Valsalva's inflation performed by the patient. Care must be taken that the vapour is not used too hot, otherwise the pharynx will be scalded. This should be repeated night and morning; on each occasion inflating the tympana four or five times.

All these vapours may be introduced into the tympanum by means of the catheter and Politzer's bag. One form of bag has a chamber in the tube, containing a sponge moistened with tincture of iodine. Again, the following will be found to be a very simple method for introducing chloroform, ether, or iodide of ethyl vapours. Remove the tube from the Politzer's bag, pour in five or six drops of the ether, chloroform, &c.; refix the tube, and after allowing a short time for evaporation, the bag will be filled with the vapour. This may be used through the catheter or by the ordinary method of Politzerisation. There is good reason to believe that the vapours of chloroform and ether are more readily introduced into the tympanum than atmospheric air.

Fluids, such as warm solutions of bi-carbonate of soda, chloride of ammonium and iodide of potassium may sometimes be introduced into the tympanum with benefit; but they must always be used with caution as there is some danger of setting up acute inflammation, especially in children.

Fluids may be introduced by one of the following methods:—

1. A little of the warm solution having been injected into the nose, the head is tilted backwards and downwards towards the side to be treated; by forcibly performing Valsalva's inflation, the patient can then readily drive the fluid into the tympanum.

2. Through the catheter. This should be introduced into the Eustachian tube; a few drops of the warm sterilized solution is then injected by means of an ordinary syringe (previously rendered aseptic), and the bag used to blow it into the tympanic cavity.

3. Through an artificial or pre-existing perforation in the membrana tympani.

The late Mr. Hinton was in the habit of perforating the membrana tympani, and then injecting the warm solution by means of a syringe which fitted closely into the meatus; thus, the fluid was driven right through the tympanum and Eustachian tube. His object was to wash out the mucus from the tympanic cavity, but in my opinion it is far too rough a method to be recommended; indeed, numerous cases of permanent injury having resulted from the practice, it has now been almost entirely discontinued.

In non-suppurative catarrh my own experience has led me to abstain altogether from the introduction of fluids into the tympanic cavity, except in certain chronic cases occurring in middle life.

Use of internal remedies.—In certain cases of dry catarrh and especially in the dry catarrh of old age, the use internally of iodide of potassium so as to produce coryza, thus simulating the running stage of a cold, is very beneficial, more particularly whenever the sides of the Eustachian tube have stuck together.

It should be given in small doses (see Appendix), with some diffusible stimulant such as ammonia; it acts best if given in hot water and after meals, and its use ought to be continued for two or three weeks. The least possible coryza is all that is necessary.

The removal of growths.—The removal by the methods indicated in Chapter VII. of any growths that may be likely to excite or keep up the catarrh is of course essential; and we must bear in mind that, as I have already said, two or three causes of catarrh frequently co-exist in the same case.

Free supply of air to the tympanum.—We now come to the second object of treatment, viz., how to bring a due supply of air to the tympanum.

This may be effected by one of the following plans.

Valsalva's method of inflation (p. 43). This by itself is generally insufficient, but the knack being easily learnt, it is often a ready means of keeping the Eustachian tubes patent after they have been opened up by some other method of inflation. The patient must, however, be cautioned against repeating it too frequently, lest he render the membrane flaccid, which always proves an awkward complication.

Politzer's method (p. 43). The use of this is almost always advantageous, and may be repeated once or twice a week, or occasionally every other day, but in the latter case the treatment should not be continued for more than ten days or a fortnight. A more frequent

or more prolonged use of inflation is often recommended, but I think it will be found that under such circumstances there is a tendency to over-distend the tympanum, so that the improvement in the hearing after inflation rapidly disappears and may ultimately become a negative quality.

The *catheter* must be used when Politzer's bag alone fails to open the Eustachian tube satisfactorily, or when it is important that the Eustachian tube of one side only should be treated. Or again, when it is desirable to introduce special vapours or solutions into the tympanum.

Should inflations of ordinary air by these means fail, they may succeed if ether or chloroform vapour is used instead. Sometimes too, the inflation, previously impossible, becomes feasible after the production of coryza, by means of iodide of potassium as already mentioned. Too frequent catheterization is open to the same objections as the too frequent use of Politzer's bag.

Many aural surgeons make use of the Eustachian *bougie* when there is a difficulty in opening the tube. This is introduced through a catheter previously passed into the Eustachian tube, and then insinuated with a rotary movement gently forward right through the tube. It is important to be extremely gentle in passing the bougie for the first quarter of an inch after it has left the beak of the catheter (Guye); after that it may be pushed forward more boldly. Two mishaps from the use of the bougie have been reported:—(1) The lining membrane of the Eustachian tube has been wounded, and subsequent inflation of the tympanum has given rise to surgical emphysema (p. 48). (2) The tip of the bougie has broken off setting up inflammation, &c., but the possibility of this accident occurring is of course

minimised by the improved instruments now used. Partly on account of these risks, but chiefly I think because they doubt the value of the operation itself, all, or nearly all, English and American aural surgeons had abandoned the bougie; of late years, however, there has been a tendency in some quarters to revert to its use, though I do not myself view the proceeding with much favour. On the Continent however, the bougie, almost from its first introduction, has been much recommended and employed, although Prof. Politzer, and some other leading surgeons have discontinued its use. Politzer substitutes for it in certain cases a minute india-rubber bag introduced through the beak of the catheter and then inflated, somewhat after the manner of Barnes' uterine bag.

There is one other method of bringing air into the tympanum, and that is by perforation of the membrana tympani itself. Sir Astley Cooper found that the hearing of a certain deaf patient was considerably improved by perforation of the membrana tympani, but that the improvement passed off in a day or two owing to the rapid closure of the aperture. Since then surgeons have from time to time performed this operation with similar results. Many plans for keeping the perforation open have been suggested and tried, but none have been really successful. Professor Paquet (Lille)* removes a large portion of the membrane, and has, in a few cases, succeeded in preventing the perforation from closing for a considerable period, in one instance for two years. Again, Kessel recommends the removal of the tendinous ring of the membrane to prevent its repair. On the whole we may say that

* "Diseases of the Ear," *Transactions International Medical Congress*, London, 1881, p. 4.

although theoretically this perforation of the membrane would be a very advantageous method of ventilating the tympanum, yet practically, the method is of little real value as it is almost impossible to keep the perforation open.

Of the many other operations which have been suggested and performed in these advanced cases reference may be made to the following, viz., division of the tendon of the tensor tympani muscle; division of the folds of the membrana tympani caused by its extreme retraction. These, like perforation of the membrane, have both been abandoned as useless or worse than useless. More recently, removal of the malleus and incus (p. 158) has been advocated, particularly in America, but the real value of this proceeding in these non-suppurative cases is not as yet generally admitted. Lastly, some surgeons, especially Dr. Clarence Blake, are carefully and scientifically trying the effect of removing the stapes, but up to the present at any rate even Dr. Blake's results can hardly be said to be very encouraging.

Restoration of the membrana tympani to its normal position.—The third object of treatment is the restoration of the membrana tympani to its normal position. The general methods used to accomplish this are the various modes of inflation just referred to; or the membrana may be forced outwards by exhausting the air in the meatus, either by means of the mouth and a tube fitting tightly into the meatus, or with Siegle's pneumatic speculum, or by using some other form of suction apparatus.

The membrana tympani frequently becomes adherent to the promontory, in which case it is important to separate it, if possible. This may occasionally be done

by forcible inflation, by means of the catheter and Politzer's bag, especially after the exhibition of iodide of potassium internally.

Passive movement of the chain of ossicles.—This is sometimes termed "massage" of the middle ear, and its object is to increase the mobility of the ossicular chain. Many ingenious plans have been devised, in all or nearly all of which advantage is taken of the fact that in consequence of the attachment of the malleus to the membrana tympani, movements of the latter give rise to corresponding movements in the incus and stapes. Of these plans probably the most scientific is that employed by Dr. Delstanche. After injecting a few drops of liquid vaseline through the Eustachian tube into the middle ear, the membrana is moved to and fro by means of a specially devised air-pump adapted to a Siegle's speculum. The pump is so constructed as to permit of the amount of pressure being accurately regulated.

Prognosis.—In early life, *i.e.*, before fourteen or fifteen years of age, the prognosis of chronic non-suppurative catarrh is usually most favourable, even in very severe cases. Sometimes the disease will yield to very simple remedies, such as the use of an astringent gargle and occasional Politzerisation. In later life the prognosis is less and less favourable; the tendency to increased thickening of the tympanic mucous membrane causes the deafness to progress steadily until the patient becomes very hard of hearing, although he never becomes stone deaf unless the internal ears are also affected.

There are few cases, however, that will not derive some benefit from persistent treatment, and it must be borne in mind that wherever we have to deal with a

bad case of deafness, any improvement of the hearing power is an immense gain to the patient, and will be highly appreciated by him.

Adhesions producing anchylosis of the ossicles; fibrous bands binding down any of the ossicles to the wall of the tympanum, such as occur between the stapes, and the pit or depression in which it rests (fig. 28); adhesions of the membrana tympani to the promontory, and the less frequent occlusion of the Eustachian tube from adhesions between its walls; all these of course are very unfavourable conditions. It must be remembered too, that the rheumatic occasionally, and the syphilitic more frequently, are particularly prone to these adhesions; before giving a prognosis, therefore, we must make careful inquiries in these directions.

A somewhat rough guide may be obtained by observing the effect of inflation upon the hearing power, the prognosis being favourable in proportion to the improvement produced. Again, the amount of mobility in the membrane may be looked upon as another guide.

Serous Fluid in the Tympanum.

The existence of serous or mucous fluid in the tympanum, in connection with chronic catarrh, was formerly considered as a not infrequent occurrence; more recently, however, aural surgeons have come to the conclusion that it is indeed very rare in this country. In acute inflammation of the middle ear it is true that the exudation is at first serous, but generally speaking it soon becomes purulent or is absorbed; on the other hand it is quite possible that in some cases, especially

in certain races and localities, this serous fluid may persist. Whenever fluid of this sort does exist in the tympanum, puncture of the membrane (p. 104), followed by Politzerisation will at once evacuate the fluid, and as a rule will immediately improve the hearing.

Sclerosis.

Progressive tympanic deafness, non-proliferous catarrh, sclerosis, fibrosis. All the above names have been given to a certain form, or possibly, to many forms of middle ear deafness the pathology of which is yet a matter of extreme doubt.

These cases are frequently complicated with a certain amount of true catarrh, but this is not at all a necessary accompaniment. Sometimes, too, they may result from paresis of the tympanic muscles, as suggested by Weber-Liel and Woakes; while Politzer from his recent researches is strongly of opinion that more or less anchylosis and immobility of the stapes is the essential factor in all cases of true sclerosis, there still remains, however, a large residuum of cases, probably of an atrophic character, whose pathology has not hitherto been explained.

The condition is more frequent in females than in males; is very apt to come on between twenty and thirty, especially in anæmic patients; and often appears to be the result of a strongly hereditary tendency. In these cases especially, we find increased deafness at parturition, this increase remaining more or less permanent. Again, we meet with a somewhat similar condition in old age, but here it is usually associated with diminished functional activity of the auditory nerve from senile changes.

Appearances, symptoms, and diagnosis.—Although but little is known of the true pathology of these changes, yet an uncomplicated case is easily recognised. The symptoms, with the exception of the deafness, are entirely negative. The meatus generally presents a pearly whiteness and absence of cerumen and hairs; the membrane may be quite normal in appearance; the Eustachian tube is readily opened, but the hearing is not improved by inflation. The bone-conduction as indicated by the tuning-fork test, &c., is exaggerated, except in some very advanced cases in which no doubt the internal ears are secondarily affected. The fauces in a typical case present no appearance of catarrh, but there is marked anæmia of the uvula and soft palate, with a bright blush on each side above the tonsils. This is perhaps the most characteristic sign of the disease. The deafness comes on very gradually, increasing by slow degrees until the patient is very hard of hearing, but not stone deaf. In advanced stages of this disease the peculiar symptom of hearing better in a noise (see Chap. XIII.), may become very marked, and this, as before stated, must be regarded as a very unfavourable sign.

Treatment.—This is most unsatisfactory. As a rule there is little or nothing to be done beyond attending to the general health, and treating such conditions as might otherwise accelerate the march of the disease. Thus, anæmia, especially where associated with amenorrhœa, &c., should be carefully attended to. Should any catarrh exist, it must be treated according to directions already given. In some cases, even where there is no evidence of catarrh, the prolonged use of iodine inflations appear to be beneficial.

CHAPTER VII.

HYPERTROPHIED TONSILS; ADENOID GROWTHS IN THE NASO-PHARYNX; HYPERTROPHIES AND GROWTHS OF THE NASAL MUCOUS MEMBRANE.

THE intimate anatomical relations which exist between the tonsils, the naso-pharynx, the Eustachian tubes and the nose, afford a ready explanation of the frequency with which ear disease is found to be associated with affections of one or other of the structures and cavities mentioned; this is more particularly the case when these affections interfere with the due ventilation of the tympanum through the Eustachian tubes, or when they form a starting point for the extension of catarrh through the tubes to the tympanum. Of late years considerable attention has been directed towards these points, with much advantage to treatment, and I need not therefore make any apology for devoting a separate chapter to their consideration.

HYPERTROPHIED TONSILS.

Although enlarged tonsils cannot possibly, from their position, directly block the Eustachian tube, yet from their pressing the surrounding tissues upwards, there is no doubt in my mind that they do frequently increase the obstruction; indeed their removal is occasionally followed by immediate and permanent improvement in the hearing power. Hypertrophied tonsils should be removed whenever they are so large that they

interfere with the free oro-nasal respiration, or when the patient is subject to repeated attacks of tonsillitis. Their removal must, however, be usually considered only as a beginning of the treatment, or as getting rid of one great source of irritation to the mucous membrane of the pharynx.

Mode of removal.—First, by the bistoury and forceps, which was at one time a very favourite method. A probe pointed bistoury must always be used, and the sharp edge of the blade should only extend about an inch from the point. The patient having been placed facing a good light and with the mouth wide open, the surgeon seizes the tonsil with the forceps, draws it towards the median line and removes it by cutting upwards or downwards as he may think best. For the left tonsil the operator should stand in front of his patient, for the right, behind; unless he happens to be ambi-dextrous.

There are some cases on record where the surgeon using this method has wounded the internal carotid artery; but in nearly all these a sharp pointed knife had been used, which was of course highly injudicious. It is also possible that in some of these cases of hæmorrhage, the injured vessel was an abnormal branch of the artery.

Removal by the tonsil guillotine.—The two chief forms of this instrument are:—

1. *The French or ring guillotine;* which consists of two rings, one, a blunt one, sliding over the other so as to cut through the tonsil by pressing it against the sharp edge of the second or cutting ring. This is the older form, and not nearly so practical as the spade guillotine, both on account of its being more complicated, and also because it takes up more room in the throat.

2. *Mackenzie's spade guillotine.*—This is by far the most useful instrument for removal of tonsils, and for ordinary cases is to be preferred both to the ring guillotine and to the bistoury and forceps, as it is safer and easier to manage, besides having the advantage of enabling the tonsil to be removed more evenly; for when the knife is used the cut surface is necessarily somewhat concave, owing to the tonsil having been pulled forward by the forceps previous to its removal.

The spade guillotine consists of a long flat blade, like a spatula, with a large circular or oval opening at one

FIG. 30.—Mackenzie's Spade Guillotine.

end, and at the other a handle which is set at almost right angles to it. Sliding on this blade, in suitable grooves, is a spade-like instrument with a sharp cutting edge (fig. 30). The spade being withdrawn from the opening, the instrument is introduced into the throat so that the tonsil passes through it. The surgeon then pushes down the spade with his thumb and the tonsil is thus cut off.

A fork is sometimes added to the instrument to hold the tonsil, but this, to my mind, is a useless complication and only gets in the way. The tonsil always

comes away with the guillotine, so that practically there is no danger of its falling down the throat.

Considerable knack is required to do this operation neatly, but when once the knack is acquired there is rarely any difficulty other than persuading the patient to keep the mouth open. Nor is this, as a rule, a difficult matter, for the spade guillotine is not a formidable looking instrument, and you can promise that there will be but little pain in the operation; indeed, very frequently there is none at all.

The surgeon should have by him two or three sizes of this guillotine, as it is important that the hole should be no larger than will effectually include the whole tonsil.

In removing the second tonsil when the bleeding from the first obscures the view, much assistance may be gained by introducing the forefinger of the left hand to to guide the tonsil into the ring and to feel that nothing else is included.

Other appliances are sometimes used, such as the galvano-cautery, écraseur, special scissors, &c., but under ordinary circumstances I do not recommend them in preference to the methods above described. Occasionally when the tonsils are very flat, or when the patient persistently objects to any cutting operation, the galvano-cautery may be used with advantage, and is far better than the old method of attempting to destroy them with strong caustic pastes.

Occasionally there is some little inflammatory swelling a few days after the operation, and therefore I am in the habit of ordering a permanganate of potash gargle for the first four or five days. Should ordinary food irritate the cut surfaces, then it must be taken in a fluid or soft form, but very frequently this is quite unnecessary.

Removal of tonsils must never be attempted in patients of a hæmorrhagic diathesis, nor should the operation be performed during acute inflammation or ulceration, especially if it is of a syphilitic nature.

The hæmorrhage following after the removal of tonsils is rarely of any moment, but should it be troublesome, the application of perchloride of iron in the form of a *saturated* glycerine solution will certainly stop it, unless the patient is hæmorrhagic or a large artery has been injured. In the latter very remote contingency, ligature of the common carotid is necessary.

Adenoid Growths in the Naso-Pharynx.

Dr. Meyer of Copenhagen* was the first to direct attention to the part played by hypertrophied adenoid tissue in the production of naso-pharyngeal stenosis; he also pointed out, that in this condition the passage of air was retarded, not only through the nose but also through the Eustachian tubes, and that hence deafness was frequently the result.

These observations of Dr. Meyer's were quickly confirmed by others, notably by Dr. Guye of Amsterdam and Dr. Lœwenburg of Paris, and have since been universally accepted. Of late years too, many of the symptoms hitherto classed as of "nervous" origin such as laryngismus stridulus, asthma, &c., together with certain malformations of the nose, mouth, and chest have been traced to the presence of these growths.

Pathology.—Adenoid tissue is, of course, one of the normal constituents of the naso-pharyngeal mucous

* "Medico-Chirurgical Trans.," 1870, p. 53; "Transactions of International Medical Congress," 1881, vol. iii., p. 278.

membrane, but its distribution in that region is by no means uniform. In certain situations this glandular element is especially developed; for instance, in the wall of the pharynx immediately opposite the posterior nares the glands are so abundant as to form a distinct mass, known as the pharyngeal or Luschka's tonsil, secondly, they will be found to be more numerous along curved lines drawn from the pharyngeal tonsil down each side of the pharynx, but in these situations the adenoid accumulations are neither so dense nor so uniform as in the pharyngeal tonsil itself. It is to the hypertrophied condition of this glandular tissue that the term "adenoid vegetations" is applied, and, as we might expect, the enlarged pharyngeal tonsil itself usually forms the chief mass in such cases.

In size, shape, and consistence these growths vary very much. In size they may be large enough to block up the whole of the naso-pharynx and effectually prevent blowing the nose, or they may only occasion a slight obstruction to nasal breathing. Under the influence of a damp climate, or during the course of an ordinary cold they almost invariably enlarge. Exposure to sea air or a dry climate causes them to shrink, while in early adult life they tend to more or less complete atrophy.

In shape the growth may form a single, thick, cushion-like mass, or there may be numerous semi-polypoid vegetations.

In consistence, they are generally very like liver, or boiled tapioca, but occasionally they are much firmer.

Causes.—Adenoid vegetations are very prevalent in damp cold districts, and less so in dry climates. Children are especially prone to be affected, and the growths are less and less frequently met with from puberty upwards, although I have seen one marked

case in a patient over fifty; on the other hand they occur not infrequently in infants at birth.

They are, I believe, very apt to appear as a sequela to such diseases as diphtheria, scarlet fever, and measles; the specific and debilitating effects of such fevers apparently rendering the patient more liable to these and other glandular enlargements. Finally, there is no doubt that this condition may be hereditary, or as it is sometimes termed "run in families."

FIG. 31—Facial aspect in a case of adenoid vegetations (from a photograph). Cresswell Baber.

Symptoms and diagnosis.—The facial aspect of a typical case is well represented in fig. 31. The mouth is half open, the alæ-nasi compressed, the buccal folds lost, and the child has altogether "a stupid appearance" and is occasionally stunted in its development.

The history of such a case will usually be as follows:—Deafness for some years, varying in degree, worse in winter and on catching cold; frequent attacks of earache, especially if the child is very young; disturbed

nights; sleeps with mouth open and consequently wakes up with a dry mouth and tongue in the morning. If we draw the child into conversation we quickly learn that the nasal resonance is almost entirely lost, and there is consequently an inability to pronounce the "m" and the "n."

Nasal respiration is either very defective or quite absent, so that the child, even in the day-time, habitually keeps its mouth open, and quickly gets out of breath if oral respirations are suspended even for a short time, as in attempting to drink a glass of water.

Not infrequently otorrhœa is met with as a complication. As a rule Eustachian ventilation is impeded, so that on using the speculum we find that the membrana tympani is much retracted; this may usually be overcome by inflation with Politzer's bag, and the hearing greatly improved, but these effects are usually quite transitory.

On looking into the mouth the tonsils may be found to be enlarged, and, possibly, a few polypoid vegetations actually seen on the posterior wall of the pharynx, or immediately behind the free edge of the soft palate. But neither of these conditions may be present; and we can never be certain either of the presence or absence of adenoid growths until the naso-pharynx has been examined by posterior rhinoscopy, or, better still, explored with the finger in the manner described on p. 41. If this be done the diagnosis can readily be made and the actual degree of obstruction easily estimated.

In the above description of course the local effects of the growths have been chiefly considered, but it must not be forgotten that in some instances other conditions may occur which suggest the existence of this form

of obstruction; for instance, Dr. Eustace Smith* insists that in very young children symmetrical retraction of the infra-mammary regions, and depression of the ensiform cartilage owe their origin, with few exceptions, to the presence of adenoid vegetations.

Treatment.—In a certain proportion of cases, where the masses are not large, the condition may be reduced sufficiently for all practical purposes, by adopting the treatment already suggested for chronic catarrh (p. 111) making use of the stronger astringents there mentioned, *e.g.*, tannin, chromic acid, &c.; but, to be of service, this treatment must be persisted in with the greatest regularity for at least three or four weeks.

More active measures are always indicated when the growths are abundant, or interfering in any marked degree either with nasal breathing or with Eustachian ventilation; remembering, however, that the Eustachian tube may become blocked without the occurrence of any decided nasal obstruction, and *vice versâ*, hence the importance of thoroughly examining suspected cases. Again, their removal is imperative where they are the exciting cause of recurrent acute catarrh (p. 105).

Removal of Adenoid Growths.—Meyer himself recommended crushing forceps and the ring knife introduced through the nose, and guided into position by the finger passed behind the soft palate. For use through the mouth, Lœwenberg devised the well-known forceps which bear his name, and he also employs the galvanocautery; Delstanche uses forceps of a somewhat different pattern. Roosa, Göttstein, Guye, and Delstanche, have all devised angular or curved curettes for use through the mouth. In certain cases Hartmann

* *Lancet*, May 25th, 1895, p. 1298.

employs a snare passed down the nose. Guye, Baber and others have at one time or another advocated the use of the finger nail.

The operation, however performed, is always unpleasant and sometimes very painful, and as the patients are usually children, the feeling of suffocation which follows the introduction of the finger or an instrument into the pharynx, is frequently intolerable and leads to violent struggling. Of the value of cocaine in these cases I have no very high opinion ; in addition to other drawbacks which have been urged against its use, I have never found that it obviated the distressing feeling of suffocation to which I have referred. For these reasons I prefer to place the patient under a general anæsthetic.

Of the methods of operating above alluded to, those which appear to me to be the most satisfactory are (*a*) the finger nail, (*b*) Lœwenberg's forceps (*c*) Göttstein's curette.

The finger nail operation.—This is the plan which I adopt and very much prefer.

The method of operating is as follows, viz. :—The patient lies on a narrow couch with his body raised nearly to a right angle; after he has been thoroughly anæsthetised by means of nitrous oxide and ether in combination, the legs are allowed to fall on either side of the couch, a gag is introduced between the teeth and the mouth opened to its full extent. The forefinger of the right hand is then passed well up behind the soft palate, and, at the same time, the body is strongly flexed upon the thighs, so that the head of the patient hangs over a bowl between his knees.* The whole of

* This position was suggested to Sir William Dalby and myself by Mr. Woodhouse Braine.

the affected mucous membrane is then subjected to a thorough scraping with the finger nail, so as to break down and completely remove all the adenoid masses, during which process the blood, mixed with adenoid tissue, flows freely from the open mouth and nose; this scraping must be done in a systematic and thorough manner, mere superficial scratching is quite useless.

This method, although apparently very simple, undoubtedly requires considerable knack, but when once the necessary skill has been acquired, the results will be found to be in every respect satisfactory.

The bleeding is at first often very profuse, and it is on this account that objections have been raised by some surgeons to the employment of general anæsthetics in these and similar cases, where there is some danger of the blood flowing into the larynx; but the hæmorrhage quickly stops, and even when at its height, the danger indicated may be met by adopting the procedure I have described. The advantages of this method of operating are (1) the position of the patient prevents the blood entering the larynx during the operation; (2) the rapidity of recovery from the anæsthetic obviates the possibility of blood trickling into the larynx after the operation, and lastly (3) there is much less shock and general disturbance.

The finger nail employed for these operations should be kept moderately short and of course scrupulously clean; for this latter purpose, in addition to ordinary scrubbing, I think it is of advantage to dip the finger into absolute alcohol for a few minutes before using it, for the alcohol is not only an excellent antiseptic, but also helps to preserve the nail at a proper degree of hardness. If the surgeon's nail is not adapted for the

purpose, an artificial nail or scraper may be used, as recommended by Sir W. Dalby (fig 32.)

The Forceps.—If it has been decided to adopt this method, the patient is anæsthetised in the recumbent position; by many the use of ether is objected to

FIG. 32—Artificial nail.

on the ground that undue venous congestion and hæmorrhage is produced, and for this reason the A.C.E. mixture, or even pure chloroform are preferred. The patient being anæsthetised the mouth is held widely open with a suitable gag, such as Mason's or Fergusson's, which may be kept in posi-

FIG. 33—Lœwenberg's forceps.

tion in the left side of the mouth by the anæsthetist. The operator, standing on the right side, passes the forefinger of his left hand well into the pharynx, feeling the growths and using the finger as a guide for the introduction of the forceps. The forceps are

of the pattern known as Lœwenberg's (fig. 33) or one of the many modifications of the same, and consist essentially of small semi-circular cutting edges, attached to long handles or shanks so curved as to adapt themselves to the contours of the tongue and palate; they are introduced behind the velum closed, but on coming into contact with the growths are opened to their full extent so as to include as much as possible of the hypertrophied tissue in their grip. After the first portion of the adenoid mass has been removed, the patient is turned on his right side to permit the blood to flow out of his mouth, and thus avoid unnecessary sponging or risk of asphyxia. The forceps are then re-applied in the same way, and the growth removed piece by piece, and if, on each application of the forceps, care be taken to guide them into position with the finger of the left hand, injury to the vomer, the Eustachian tubes, or undue laceration of the mucous membrane (accidents which sometimes happen to beginners) will be avoided. Some operators advise that, after the patient has been anæsthetised, he should be so placed that his head hangs well over the end of the operating table, with the neck extended; the blood then flows into the post-nasal space and out of the nostrils. On the whole I think that the lateral position is preferable.

The main adenomatous masses being removed in this way, it is as well to feel for and scrape away with the finger nail any smaller masses that may have escaped the grip of the forceps, but as a matter of fact such small masses often atrophy of their own accord without further interference.

The Curette.—The patient is placed recumbent, anæsthetised, the head drawn over the end of the table, and

the mouth opened as for the forceps operation. Personally I prefer a curette of the original Göttstein pattern (fig. 34) but modifications have been introduced by Politzer, Delstanche and others. A good light should be directed into the open mouth, and the curette is then passed upwards behind the soft palate, keeping the instrument well forward so as not to catch against the adenoid masses in its passage to the vault of the naso-pharynx; arrived at this position, the curette is pressed firmly backwards and then drawn downwards with a sweeping movement. Usually three such sweeping cuts (one median and one on either side) are necessary to thoroughly remove the growths which come away in

FIG. 34—Göttstein's curette.

large masses, and, as with the forceps, it is as well to examine and remove with the finger nail any smaller more or less isolated patches that may have escaped the instrument. All this should be done as rapidly as possible, and the patient quickly turned to one side so as to allow the blood and the large masses of adenoid tissue to pass out of the open mouth.

A not unimportant element in the complete success of these operations is undoubtedly the administration of the anæsthetic, and I agree with those who are of opinion that this duty should not be confided to an unskilled junior; when too, chloroform in any shape is given, the danger of collapse does not cease with the completion of the operation, but may and has occurred

some little time after, and for this reason not only is it advisable to watch the patient most carefully, but I also think that the anæsthesia should not be very profound.

A few cases of severe hæmorrhage after these operations have been recorded, but none have occurred in my own practice; possibly the too free use of cutting instruments may account for them, but more probably the hæmorrhagic diathesis is at the bottom of this trouble. A somewhat more frequent sequela is that of acute suppurative inflammation of the tympanum, and the possibility of this points to the necessity of avoiding operation immediately after a recent otitis, or if we have any reason to suspect dormant mastoiditis; for the same reason too I think that it is important, in the after-treatment to guard against the patient catching cold, and to be chary in the use of nasal solutions or douches.

Generally speaking the after treatment of these cases is sufficiently simple. Rest in bed after the first day is not necessary or even advisable, but the patient should be confined to the house for a few days. Occasionally the use of mild nasal injections and Politzerisation are of service, but these should not be commenced until forty-eight hours after the operation. From excessive post-nasal blocking sleeping with the mouth open is often a necessity, but the habit may be persisted in long after the obstruction has been removed. It is of some importance to overcome this habit, and for this purpose, if other means fail, a light pad (contra-respirator) may be worn over the mouth at night, as suggested by Dr. Guye.

Prognosis.—The removal of the growths is usually followed by an almost wonderful recovery of hearing power, and this recovery is generally permanent. Even

in cases where there is otorrhœa and perforation of the membrane, the improvement is almost always very striking.

In a very small proportion of cases there is no improvement, but in these it will generally be found that further mischief exists, *e.g.*, auditory nerve deafness. As these growths are merely an hypertrophy of a normal tissue, it follows that, unless the mucous membrane itself could be entirely stripped off, the whole of the adenoid tissue cannot be removed; hence we must not be surprised to find that recurrence will occasionally take place, especially if the patient is exposed to conditions which favour the production of these vegetations; but even under these circumstances, recurrence is decidedly rare, and is less frequent in children over 14 or 15 years of age than in those younger.

Nasal Growths.

There is probably a tendency just now to overestimate the importance of the relations between diseases of the nose and those of the ear; but at the same time it must be admitted, that much improvement in the treatment of ear disease has resulted from the attention which diseases of the nasal cavities have of late years received.

Those diseases of the mucous membrane of the nose which, by extension, tend to affect the Eustachian tubes, and those which produce more or less marked stenosis, are the affections which require the study of the aural surgeon. A full account of these would be *out of place* in this work, and I propose therefore to

limit myself to a brief survey of the more important of these affections under the following heads:—

1. Hypertrophy of the mucous membrane and submucous tissue of the middle turbinated body.
2. Nasal polypi.
3. Hypertrophy of the mucous membrane and submucous tissue of the inferior turbinated body.
4. General hypertrophy of the nasal mucous membrane or hypertrophic rhinitis.
5. Atrophy of the nasal mucous membrane (the so-called atrophic rhinitis) and ozœna.

Hypertrophy of the mucous membrane and submucous tissue of the middle turbinated body.—This is chiefly met with at the anterior extremity and may produce stenosis. It is quite possible to mistake this condition for a polypus, but the use of a good light, the nasal speculum and the probe should render the diagnosis easy. The previous introduction of cocaine (5 per cent. in a saturated solution of boric acid) by means of a spray apparatus or on a pledget of cotton-wool, will greatly assist in the examination by causing the submucous erectile tissue to contract, and thus enlarge the space.

Treatment.—If there is marked hypertrophy the repeated application, under cocaine, of the galvano-cautery or of chromic acid gives the best results. Occasionally if very much enlargement exists, the cold or the galvano-snare may be used with advantage. Good illumination should always be employed whilst performing these little operations. If the thickening is not great, spraying with warm alcoholic solutions (rectified spirit 1 in 5 to 10), repeated twice a day for some weeks, is very useful, as suggested by Cresswell Baber. These solutions are also very useful as an after treat-

ment when the parts have healed after cauterisation, and until the healing has taken place, weak watery irrigations (1 per cent.) of boric acid may be used.

Nasal polypi generally grow from the upper part of the nasal cavity (middle and upper turbinated bodies), sometimes from so far back that they project into the naso-pharynx. They are usually soft fibromata much infiltrated with a watery fluid; generally multiple, tending to enlarge and produce complete stenosis; usually affecting both nostrils; and often distending the nasal cavities by their pressure. They thus become a source of very great discomfort to the patient, especially at night.

Complete *removal* is the only satisfactory treatment. The old fashioned method of the forceps and torsion is rarely advisable; at best, only the largest can be removed by this plan. The cold-wire or galvano-cautery snares, used carefully and with a good view of the parts, are always to be preferred. The larger polypi present very little difficulty, unless attached far back and projecting into the pharynx, when considerable assistance will be afforded by passing the finger into the naso-pharynx. When the large ones have been removed, the smaller ones must be carefully sought for and cleared away in the same manner. All the polypi within reach of the snare having been removed, their attachments to the mucous surfaces must be seared over with the galvano-cautery, or with chromic acid. The spirit spray suggested above forms a valuable after-treatment. Several sittings and a good deal of patience may be required for the complete removal of the growths, but by the snare we may in the majority of cases, anticipate a radical cure, whereas by the older plan of forceps and torsion, the polypi almost *variably* recur.

Cocaine is most useful in these cases; applied by means of a spray, or on pledgets, it not only relieves or abolishes the pain, but, by diminishing the turgescence of the erectile tissues, enables us to obtain a far better view of the parts than would otherwise be possible, and this is a very essential element of success.

Hypertrophy of the mucous membrane and submucous (erectile) tissue of the inferior turbinated body.—Two forms of hypertrophy are now generally recognized, viz:—pseudo-hypertrophy and true hypertrophy. In pseudo-hypertrophy it is the vascular element of the erectile tissue which is chiefly affected, whereas in true hypertrophy there is a general increase in growth of all the soft parts covering the turbinated bone, and especially of the fibrous tissue.

Pseudo-hypertrophy usually affects the anterior extremities of the turbinated bodies, causing them to appear as large rounded swellings projecting from the outer wall of the nasal cavity, and sometimes blocking the passage altogether. At first sight these swellings may almost be mistaken for polypi, but the probe will readily dispel any such idea, and on the application of a solution of cocaine (5 per cent.) which should always be used in these cases, the vessels of the erectile tissue empty, the whole mass shrinks and the stenosis is temporarily relieved.

Treatment.—A pledget of cotton-wool soaked in a 10 per cent., solution of cocaine is kept in the nostril for about 15 minutes; the hypertrophied mass is then very thoroughly scored right down to the bone by means of the galvano-cautery. This is the only really effectual treatment; under cocaine it is quite painless, and the results are, as a rule, perfectly satisfactory.

True hypertrophy may affect any part of the tur-

binated body, but most frequently the anterior and posterior extremities. The disease may be so extensive that the growth becomes folded upon itself and fills nearly the whole of the inferior meatus; or the enlarged posterior extremity may project backwards into the naso-pharynx, when the dilated vessels give the mass a mulberry-like appearance (mulberry growth of Woakes). From pseudo-hypertrophy the condition can be diagnosed by its larger size, and the consequent greater stenosis; by its nodular surface, and especially by its not shrinking under the influence of cocaine.

Treatment.—In slight cases the galvano-cautery applied as above will suffice, but as a rule the snare is necessary, and it may often happen that the growth can only be removed piece by piece. In removing the mulberry-like enlargements from the posterior extremity, and especially if they are of any size, the fore-finger of the left hand must be passed into the naso-pharynx through the open mouth so as to guide the wire loop into position; the hæmorrhage is often very smart, and occasionally it is necessary to plug the posterior nares. Some surgeons advocate the removal of the whole of the turbinated body, including the bone, but this I consider very rarely advisable.

General hypertrophy of the nasal mucous membrane or hypertrophic rhinitis.—This is, as its name implies, a general thickening of the whole of the nasal mucous membrane, and is easily recognized by anterior rhinoscopy. Occasionally this condition calls for treatment with the galvano-cautery, but as a rule it is sufficient to spray or irrigate the nose with salt and water, alcoholic solutions, or some more decided astringent such as tannin, hazeline, &c. (Appendix).

Atrophy of the nasal mucous membrane, atro-

phic rhinitis, with ozæna.—In this condition the evident atrophy of the mucous membrane, and especially of the posterior part, causes the nasal cavities to appear unnaturally large. If ozæna is present the characteristic offensive smell will be at once recognized, and in such cases, the mucous membrane covering the posterior portions of the nasal cavities, will be seen to be covered with numerous greenish-coloured, offensive crusts.

Treatment.—Simple atrophy without ozæna may require no special treatment, but the case must be carefully watched, so as to check at once the slightest tendency to that distressing condition. In well marked cases of ozæna we cannot hope to do more than render the patient's life more bearable, by diminishing the offensiveness of the discharge; the crusts must be carefully removed as soon as formed, and a nasal douche containing permanganate of potash, thymol, or some other antiseptic or deodorant, must be used freely and often.

It is obvious that both the hypertrophy and atrophy of the nasal mucous membrane may indirectly involve the Eustachian tubes, and thus affect the hearing, but the scope of this work does not permit of more than the above very brief sketch of these conditions.

CHAPTER VIII.

CHRONIC SUPPURATIVE INFLAMMATION OF THE TYMPANUM, CHRONIC SUPPURATIVE CATARRH, OR INTERNAL OTORRHŒA.

THIS is one of the commonest affections of the ear: nineteen out of twenty of the so-called discharges of the ear being due to this disease; but it frequently happens that so little notice is taken of it by the patient, or even by the medical attendant, that it is left entirely without treatment. On the part of many persons, too, there is a very great reluctance to have "the discharge stopped," although such discharge is, in many cases, the starting point of mischief, which may not only destroy the hearing power of the patient, but even result in his death. I cannot, therefore, insist too strongly upon *the importance of early treatment* in every case of discharge from the ear.

Chronic suppurative inflammation is usually a sequela of acute inflammation, although occasionally it is chronic from its commencement; the latter being more especially the case in the tubercular otorrhœa which sometimes occurs in phthisis.

Scarlet fever, measles, and other exanthemata, are the most frequent penultimate causes of this condition; because, on account of the long continuance and specific nature of the primary acute inflammation, the healing tendency is diminished, there is more destruction of the parts, and more lowering of their vitality; hence the increased tendency to pass from the acute to the chronic phase.

Symptoms and Diagnosis.

Deafness, variable in degree, is a never-failing symptom, although the loss of hearing power varies in different cases, from a scarcely appreciable degree to total deafness. This variation does not depend upon the size of the perforation, but upon the amount of change in the tension and mobility of the membrana tympani and ossicles; the popular notion, therefore, that a perforation is fatal to the hearing power, is a complete fallacy. It sometimes happens, however, that the internal ear is invaded by the disease and its function destroyed, when of course the deafness is complete.

Tinnitus is an occasional symptom, though not nearly so frequent as in chronic non-suppurative catarrh.

Discharge of pus from the meatus, or at any rate from the tympanic cavity into the meatus, almost invariably occurs, although it is possible to have the disease without any discharge through the membrana tympani. In the latter cases the pus is either locked up in the tympanic cavity (a very serious condition), or else it finds an exit through the Eustachian tube.

The character of the pus differs according to the condition of the tympanic cavity and meatus.

1. *Healthy pus.*—In a typical case the discharge consists of a somewhat thin, laudable pus.

2. *Ropy.*—After recent acute inflammation the pus may be of a ropy nature, owing to the admixture of mucus.

3. *Thin or watery.*—During the healing stage, when the parts are becoming more healthy, the discharge is scanty and of a watery character. On the other hand

a thin, watery, but acrid and copious discharge, is found in neglected cases, especially in young children.

4. *Sanguineous.*—Blood is often found mixed with the discharge, and denotes the presence of some granulating surface or a soft polypus.

5. *Fœtid.*—The discharge in neglected cases is usually more or less fœtid. When excessive fœtor occurs in regularly cleansed cases, and especially when the pus is of a brownish colour, it is an indication of diseased bone, and when this discharge is profuse and persistent it will probably be found that the antrum or mastoid cells are involved.

Perforation.—With the exception of those rare cases to which allusion has been already made, *i.e.*, when the pus is either locked up in the tympanic cavity, or when it only finds an outlet through the Eustachian tube, a perforation is always present in chronic suppurative inflammation or internal otorrhœa; and, indeed, its presence or absence is the distinguishing mark between external and internal otorrhœa.

Diagnosis.—The existence of a perforation may be ascertained in several ways.

Occasionally, fluids injected into the ear will pass right through the Eustachian tube and out of the nose, or down the pharynx. This, of course, is an infallible sign of a perforation.

Again, on examining the ear with the speculum, we sometimes finds a drop of pus filling up a perforation (though apparently lying on the surface of the membrana tympani), which drop is distinctly seen to pulsate. This appearance is almost a certain sign of the existence of a perforation.

These modes of diagnosis, depending as they do upon circumstances which may be called accidental,

can only be utilised in a few cases. The two most general means of ascertaining the presence of a perforation are either by *seeing* it, or by *hearing a peculiar whistling sound*, which is produced by air escaping from the tympanic cavity when it is inflated by any of the various methods.

Before a perforation can be seen it is usually necessary to cleanse the meatus; then with the aid of the speculum the opening can, in most cases, be easily discovered. It may possibly be so small that it is not seen, or it may be invisible on account either of its valvular shape or because that portion of the membrane is outside the field of view. In these cases either Politzerisation, or inflation by Valsalva's method, should be performed while the membrane is under observation; then, should a perforation be present, a little pus bursting through will reveal its position. Or the diagnostic tube may be used (p. 42), then on Politzerisation a whistling sound will denote the existence of an opening.

Form of perforation.—The perforation may be of any size, from a minute pin-hole to that of complete, or almost complete loss of the entire membrane.

The following are the chief varieties :—

1. *Pin-hole perforation* (fig. 35 *a*).

2. *The typical one* (fig. 35 *b*), a round or oval hole of larger dimensions.

3. *Kidney-shaped perforation* (fig. 35 *c*).—If the perforation is still larger, and confined to the lower segment of the membrane, it assumes a kidney shape, due to the long handle of the malleus (which is partly denuded of membrane) projecting into it.

4. *Healing perforation* (fig. 35 *d*).—When a membrane is healing across, the margin usually presents a zone of thin, finely-injected membrane. This gradually en-

croaches on the hole until it is completely obliterated. In favourable cases this thin membrane gradually assumes the characters of the normal structure, but in others it always remains thinner than the surrounding tissue, and the difference in atmospheric pressure upon the two sides produces a cup-shaped depression.

5. *Unhealthy perforation* (fig. 35 *e*).—Here the margin, instead of being thin as in the preceding case, is much thickened, very red, and may be broken up into granulations; these granulations sometimes enlarge and form

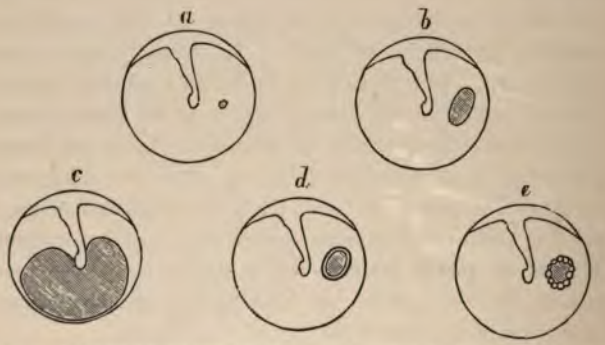

FIG. 35.—Diagrammatic sketches of various forms of perforation of the membrana tympani. *a*. The pin-hole. *b*. The typical oval. *c*. The kidney-shaped. *d*. The healing. *e*. The unhealthy, fringed with granulations.

polypi. This condition indicates a low type of inflammation of the tympanic mucous membrane.

6. *A free dry perforation.*—Sometimes we find a perforation which has cicatrized round the margin, after the suppurative disease of the tympanum has disappeared. This, I consider, is a very satisfactory result, providing that the perforation is not large; but some aural surgeons are of a different opinion.

7. *The adherent dry perforation.*—Again, the margin of

the perforation may become adherent to the inner wall of the tympanum. This condition is usually far more unsatisfactory with respect to the hearing power, but as regards the disease itself it is by no means an unfavourable termination.

8. *Perforation in the membrana flaccida.*—A perforation in this position is most unsatisfactory, both as regards the healing of the disease and also in respect to the restoration of the hearing power; in fact, otorrhœa with perforation of this part of the membrana tympani must always be considered as a condition totally different, and fraught with far greater danger to the patient, than when other portions of the membrane are affected. When the membrana flaccida is perforated, we have to deal with suppuration in the attic or upper chamber of the tympanum (p. 17), which is directly connected with the mastoid antrum, the whole forming a most intricate set of cavities (antro-tympanic). These cavities are not only very difficult to cleanse, but their intimate relation to the cranial cavity renders extension of the disease to the meninges and brain itself much more possible. Moreover, disease in the attic is liable to interfere with the attachments and nutrition of the two first ossicles, so that considerable loss of hearing power results, and not unfrequently this is associated with caries and necrosis of the malleus or incus.

I would here warn the reader of the possibility of mistaking a large foramen Rivini in the membrana flaccida, which is a normal condition in some few individuals, for a dry perforation left by disease. These foramina, when they are examined, have every appearance of being normal and not the result of disease. This, together with the existence of a symmetrical foramen in the membrane of the other ear, should be

sufficient to make the case clear, although there are many authorities who consider that such perforations are invariably due to previous suppurative disease.

The relation of perforation to the loss of hearing power.—As already stated, one of the many widespread fallacies in connection with ear-disease, is the supposition that a perforation of the membrana tympani necessarily entails extreme deafness. The truth is that a perforation, though usually producing a certain amount of diminution of hearing power, may have some compensating advantages, such as equalising the atmospheric pressure on each side of the membrane, and is far less injurious than an adhesion to the inner wall of the tympanic cavity. This will be readily understood if we bear in mind the true function of the membrane and ossicles; viz.:—to pick up the sound waves from the gaseous (atmospheric) medium and conduct them to the fluid contained in the labyrinth (p. 25). For this purpose due tension of the membrane is necessary, and also free mobility of the ossicles; and so long as these two are not interfered with, no serious amount of deafness will occur.

When, however, a very large proportion of the membrane is lost, the essential part of the conducting apparatus—the membrane and ossicles—tends to fall outwards, and so loses its due tension. In these cases a considerable diminution of hearing will probably result, but this may be partially restored by means of an artificial tympanum to be presently described.

Treatment.

The indications for treatment in these cases of chronic suppurative catarrh, are:—

1. To subdue the suppurative disease and to render the surfaces healthy.

2. To heal the perforation in the membrana tympani. This is almost entirely dependent upon the success of the preceding, because a perforation rapidly heals—either across or at its margin—when the discharge has ceased.

3. To restore the hearing power.

To subdue the suppuration.—In a simple case, thorough cleansing by means of warm injections (Appendix) is all that is necessary to induce a healthy reaction, and thus allow the *vis medicatrix naturæ* to effect resolution. To render the cleansing process more perfect, and at the same time to avoid introducing pathogenic organisms, it is very important to add to the cleansing fluid some antiseptic, such as boric acid, permanganate of potash, carbolic acid or the like; and also some one of those agents which stimulate the healing process, as acetate of lead, acetate of zinc, sulphate of zinc or alcohol.

In the majority of cases, however, something more than mere cleansing is required, and then one of the following modes of treatment should be adopted.

a. Instillations.

b. The dry treatment.

c. The absorbent treatment.

a. *Instillations.*—After the ear has been cleansed with some antiseptic injection and thoroughly drained, it should be completely, or almost completely filled with

the instillation, which must be slightly warm, the patient lying so that the affected ear is uppermost, and remaining in that position for at least 15 minutes after its introduction.

Further, in those cases where the perforation is small, the patient should perform Valsalva's inflation, by which means the fluid will be sucked into the tympanic cavity during the reaction.

Alcohol.—This forms by far the most satisfactory instillation, both on account of its stimulating and antiseptic action, and also because of its penetrating power, which enables it to make its way into all the irregularities of the bony cavity; besides which, on account of its affinity for water, it shrivels up and thus destroys soft granulations with marvellous success. Rectified spirit should be used, at first diluted 1 in 3, and rapidly increased in strength if it produces no continuous pain. Momentary stinging is of no consequence, and it is a curious fact, that often, when the first instillation of the solution produces pain, if the alcohol is allowed to drain out and a second quantity of the same strength is poured into the ear, no pain whatever will result. Occasionally, the continued use of alcohol will produce eczema of the meatus; as soon as any tendency to this is detected, the meatus should be painted with a thin layer of vaseline before each instillation.

I usually add to the alcoholic solution, powdered boric acid to supersaturation, or perchloride of mercury 1 to 1000, so as to obtain the beneficial effect of these antiseptics as well as of the alcohol (Appendix). This instillation, combined with previous syringing with some antiseptic fluid, repeated two or three times a day, is my usual mode of treatment in the majority of

cases of chronic internal otorrhœa; but I would here caution the unpractised hand against the use of alcohol in cases of inflammation of the bone, or where there is any tendency to *acute* inflammation in the tympanum.

Liquor plumbi subacet., either alone or somewhat diluted, is a very useful although old-fashioned form of instillation. It has, however, the disadvantage of covering the surface with adherent scales, which sometimes interfere with proper cleansing.

Solutions of nitrate of silver (from 10 to 20 grains to the ounce) are used by some with great advantage; but as there is some risk of inducing acute inflammation, I prefer applying such solutions by means of a mop and not as instillations.

Many other solutions might be mentioned for the purpose, but the above are those from which I have obtained the most satisfactory results.

b. Dry treatment.—An old quack was in the habit of rapidly curing chronic otorrhœa by pouring in a paste of plaster of Paris, which on setting formed a hard plug. This, although it did undoubtedly heal a large number of cases, was of course an exceedingly dangerous mode of treatment, on account of the difficulty of removing the plaster of Paris whenever it failed in immediately arresting the disease. But if, instead of this, we use other powdered substances that are not liable to cake, and so can easily be removed, we may derive much benefit from them. In fact, in a fair proportion of cases, the dry treatment is by far the best, especially in those where the discharge is slight, the perforation considerable, and where granulations are not present, or at any rate, not abundant.

Numerous powders have been tried for this purpose, and among others powdered French chalk used to be

strongly recommended; but all have now given way before the superior claims of boric acid.

Mode of application.—After the meatus has been thoroughly cleansed by syringing, the ear must be filled with finely-powdered boric acid, which should have been passed through a silk sieve to remove any small crystals that might become a mechanical source of irritation.

The ear may be filled either by blowing the powder into it through a quill,* or by using the speculum as a funnel, for which indeed it is admirably adapted; the powder being gently rammed down by means of a cotton-wool mop. Finally, a small piece of cotton-wool should be inserted into the mouth of the meatus for the purpose of keeping the powder in its place. This process should be repeated from once a day, to once in three or four days, according to the amount of discharge; and as the discharge diminishes the powder may be left in as long as a week or even a fortnight. The cotton-wool should be removed by the patient every day, so as to ascertain whether the discharge has soaked through, in which case the whole must be syringed out and the process repeated.

Excellent results may be obtained by this method, especially when dilute alcohol is used for the cleansing injection, the healing process sometimes being extremely rapid; for instance, I have notes of one of my cases, where a single application was sufficient to conquer a discharge of nine years' standing.

c. The cotton-wool or absorbent treatment.—This may be regarded as another form of dry treatment. It consists

* For this purpose the quill should be fitted to a piece of india-rubber tubing ten inches in length, mounted at the other end with a mouth-piece of glass-tubing.

of applying cotton-wool (absorbent cotton-wool), by which means the discharge is soaked up as rapidly as it is formed, while the diseased surfaces are protected both from the action of the cold and the access of fresh septic germs.

Mode of application.—After cleansing the meatus, a long wick-shaped piece of cotton-wool is inserted by means of a pair of forceps, (fig. 39), then gently pushed down to the tympanum and there allowed to remain. This should be changed once or twice during the day, according to circumstances, the meatus being cleansed each time if necessary.

Instead of using the simple cotton-wick, it may be saturated with some antiseptic or other healing solution. Or again, the cotton-wool may be prepared with some of these substances in the dried state; thus the ordinary antiseptic boric acid or salicylic wools may be used, and indeed I prefer these to all others when the absorbent mode of treatment is adopted.

This method is most advantageous in those cases where there is only a slight discharge, and where other modes of treatment are not readily borne; as for instance, where the ear will not bear much syringing.

A more thoroughly antiseptic method of treatment, similar to that which I have recently employed for granulations and polypi (p. 176), is also very useful in many cases of otorrhœa, and is, in fact, but a modification of the absorbent method.

Clinical experience alone will enable the practitioner to decide as to which of these foregoing methods should be used in each individual case, but the following general rules may assist him in his decision.

When the discharge is profuse, the use of repeated injections is naturally indicated; if fœtid, the addition

of carbolic acid or other strong disinfectant, becomes necessary. Any tendency to acute inflammation, as already stated, contra-indicates the use of alcohol, though not of boric acid powder.

When a boric acid or a zinc and carbolic acid injection fails to arrest the discharge, although it has considerably lessened it, then the alcoholic, the dry, or the absorbent method, will usually succeed. Should there be any sign of latent bone mischief, it may be unwise to heal the discharge too rapidly; in such cases, if the diseased spot itself cannot be reached and treated by scraping, &c., injections of carbolic acid and zinc, or of boric acid are to be preferred.

Mode of syringing the ear.—Generally speaking, a patient cannot syringe his own ears properly, except when only very gentle syringing is required, in which case he should make use of an india-rubber ball syringe.

When the friends of the patient are entrusted with this office, it is best to order an ordinary straight glass syringe as this is not so liable to be used too forcibly. In cases where thorough syringing is necessary, a one ounce brass syringe with a fine nozzle (p. 70) should be employed; where the syringing produces pain or severe giddiness, Clarke's douche or some modification of the same should be used (fig. 36).

In some obstinate cases, especially if associated with accumulations of caseous or cholesteatomatous material in the tympanum (p. 201), syringing through the Eustachian tube will much facilitate the cleansing and expedite the healing. The fluid used must be of a very mild, unirritating character, a weak solution of common salt, sterilized and warmed is probably the best; it is

injected by means of a syringe or douche attached to the Eustachian catheter. It must be remembered, however, that as the Eustachian tube opens into the front part of the tympanum proper, this method of syringing is not effective so far as the attic is concerned, and moreover, it is in the attic that these accumulations are most liable to occur.

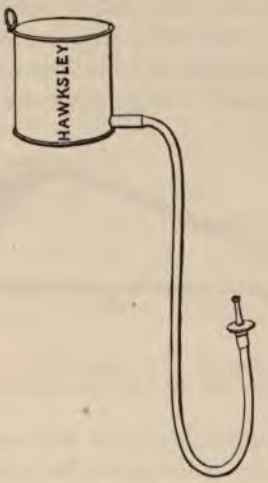

FIG. 36.—Clarke's ear douche.

When the antro-attic cavity is the seat of the suppuration, the perforation in the membrana flaccida is generally too small, either for proper drainage or for the effectual use of the ordinary syringe. Special means must therefore be adopted for cleansing this otherwise inaccessible and irregular cavity. For this purpose some form of intra-tympanic syringe becomes necessary. Dr. Hartmann (Berlin) uses a ball syringe

with a long fine metal tube bent at the tip; Dr. Delstanche has devised one of a much more complicated pattern. That which I use (g. 37) is somewhat similar in shape to Hartmann's.

In using these syringes the meatus and membrana tympani must be well illuminated; the fine nozzle is then introduced through the perforation and the stream of fluid is directed backwards. This procedure, though very effectual, is only possible for the surgeon himself; for every-day use by the patient, I order a small brass syringe, to the nozzle of which a fine piece of rubber tubing about an inch long is at-

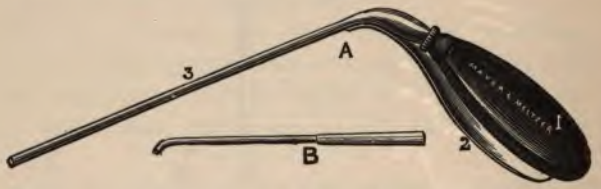

FIG. 37.—Intra-tympanic syringe. A. 1. Rubber bag. 2. Spoon-shaped metallic support. 3. Straight tube. B. Tube with curved nozzle fitting on to 3.

tached, this tubing being quite soft and pliable cannot injure the delicate structures with which it may come in contact, and it may therefore be passed right up to the perforation itself. By these means not only can the cavity be more thoroughly cleansed, but instillations can be more readily introduced.

Removal of the malleus and incus.—It has already been pointed out (p. 11) that the malleus and incus, together with the folds of mucous membrane connected with them, complete the barrier or partition separating the antro-attic cavity from the cavity of the tympanum proper; and it is obvious that so long as

this barrier exists, access to the antro-attic cavity will be, if not impossible, at any rate very difficult or a mere matter of chance. There is, further, no doubt, that the obstinacy with which many cases of otorrhœa resist treatment is in great measure due to the fact, that this practically inaccessible cavity is more or less involved; and moreover, these ossicles are themselves often the seat of necrosis or caries.

Under these circumstances it has been suggested by Dr. Sexton of New York, and others, that the most effectual way of opening up the antro-attic cavity is to break down the barrier by removing the ossicles; and it has been shewn by experience that further diminution in the hearing power need not, as a rule, be feared, in fact it is sometimes much improved.*

There is no doubt that the anatomical and pathological arguments in favour of the operation are sound, and the results which have followed the adoption of this plan in a considerable number of cases are sufficiently encouraging.

It is, of course, very difficult to decide upon the propriety of operating in any given case; but it may be laid down that removal of the ossicles is advisable if every other form of treatment has been persisted in for some time without success, and especially if (as is often the case) a carious spot on an ossicle can be detected by means of a probe passed through the perforation in Shrapnell's membrane.

Operation.—The meatus and adjacent parts should, as far as possible, be rendered aseptic beforehand by means of injections, instillations, and compresses of carbolic lotion (1 in 40). Personally I prefer that the

* In one of my own recent cases, for instance, the hearing was restored nearly to the normal.

patient should be under a general anæsthetic, but by some surgeons cocaine is considered better, as it reduces the hæmorrhage; when anæsthetised, the head is held in position and some trouble is taken to secure the most perfect illumination of the membrana tympani.

The first step in the operation is to release the malleus from its attachments to the membrana, by cutting through the latter structure close to and all round the handle of the malleus, commencing at the perforation in Shrapnell's membrane, passing first downwards by the side of the handle and then upwards along the opposite side until the opening in Shrapnell's membrane is again reached. For this purpose Sexton's specially devised knife is employed; in general shape and appearance this instrument is very similar to the perforator depicted on page 104, but a short ($\frac{1}{8}$ in.), thin knife-blade with the cutting edge upwards, is substituted for the spear-shaped point. The malleus is practically now only held by the tendon of the tensor tympani muscle, and this is divided by means of Delstanche's "Extracteur du Marteau," a small, oval, ring-knife in a handle set at the same angle as Sexton's knife. The ring of this instrument is threaded on to the handle of the malleus from below, then raised, and, guided by the malleus itself, readily cuts through the tendon; the substitution of Delstanche's "Extracteur" for the angular knife formerly used renders this part of the operation much easier, as the ring can be slipped over the malleus even when blood obscures the view. By means of a little rocking movement backwards and forwards the whole malleus can now be detached, and is either brought out in the ring, or drops into the meatus and is removed with forceps.

The removal of the incus is a matter of greater delicacy

and difficulty, though sometimes, especially if ankylosed, it comes away with the malleus without further trouble. At this stage the meatus is usually filled with blood and the parts quite hidden from view; it is better therefore, to syringe out the ear with a little lotion, and if need be, wait for a few minutes for the hæmorrhage to subside. The tip of the long process of the incus may then often be brought into view, seized with a pair of forceps, drawn downwards, and removed; but if this is not possible—and it is far from easy—a small, blunt, angular hook is passed upwards into the attic behind the incus, and by gently rotating this hook the ossicle is pushed forwards and downwards into the lower part of the tympanum, where it can be gripped by the forceps; the attachment between the incus and stapes is so fragile that it need not be taken into account.

The whole ear is now carefully syringed out with carbolic solution (1 in 40), and packed with double cyanide gauze wrung out of the carbolic lotion.

No complications or bad effects should follow the performance of this operation, but if the antiseptic precautions are not rigidly carried out, inflammatory granulations frequently appear, but even these usually subside in the course of a few days, or yield to chromic acid applications and alcoholic instillations.

The antro-attic cavity is now quite accessible to the surgeon, and consequently some of the cases hitherto considered incurable have yielded to treatment; but it must be admitted that there is still a large number of cases of suppuration in the attic which resist all the efforts of the surgeon.

If the disease should extend at any future time producing mastoiditis, and it should become necessary to open the antrum from behind the auricle (p. 191), the

previous opening up of the attic will enable us to syringe freely through from the meatus to the wound, and *vice versâ*.

Accessory Treatment:—

Naso-pharyngeal and Eustachian.
Counter-irritation.
General health.

Naso-pharyngeal and Eustachian.—As by far the larger number of cases of chronic suppurative catarrh have their origin in naso-pharyngeal catarrh, it behoves the surgeon to treat these parts as carefully as the disease itself. It often happens that a discharge which has obstinately refused to yield to direct treatment, is soon overcome when the naso-pharynx and the Eustachian tube receive proper attention.

Counter-irritation behind the ear, by means of liniments, mustard, iodine, and best of all, blisters, is occasionally a very useful adjunct to the direct modes of treatment; this is especially the case where there is any tendency to acute inflammation or active congestion of the mucous membrane of the tympanum (as indicated by the pulsation of the pus, see page 146), or where any disease of the bone exists.

General health.—Due attention to general health should never be forgotten in treating the local condition.

In infants and strumous patients, constitutional treatment is almost always required. The necessity for proper diet, good air, &c., must be insisted upon; and tonics, such as phosphates of iron, quinine in small doses, cod-liver oil and the like, are invaluable in many cases, although of course each individual one must be treated according to its own peculiar requirements.

The importance of this cannot be too strongly insisted upon, as there is great tendency to lose sight of

the fact that the ear is only part of the whole, and must therefore be influenced by the health of the rest of the body.

The artificial membrana tympani.—In 1841, Dr. Yearsley discovered a very valuable means of improving the hearing in certain cases of perforation of the membrana tympani. He was led to this discovery by a patient, who showed him how he was able to restore his hearing in one ear by introducing a quill of paper right down to the injured membrane. Yearsley found this was correct, and that it answered in many other similar cases; he, however, substituted cotton-wool for the paper, and this, in some form or other, is still the favourite material. Toynbee soon after obtained the same results by means of a disc of sheet india-rubber, with a wire or piece of thread attached to the centre (fig. 38*b*).

There have been many modifications of the so-called artificial tympanum since those of Yearsley and Toynbee, and the forms now most generally in use are:—

1. Yearsley's cotton-wool pellet.
2. The wick.
3. Toynbee's.
4. Various discs of paper, linen, &c.

Yearsley's is a moistened pellet of cotton-wool, to which a piece of thread is generally attached.

The wick is merely a modification in form of Yearsley's, and consists of a wick-shaped piece of cotton-wool, moistened, and pushed down to the membrane. This is by far the most useful of all forms of artificial tympana, both on account of its easy application and removal, and also because it is less liable to become displaced, being kept in position by the larger surface it presents for support against the

walls of the meatus. I prefer salicylic wool moistened with a fairly hot solution of carbolic acid containing a little glycerine (glyc. acid. carbol. ʒi., aq. ʒi.); this has all the advantages of an antiseptic dressing, while the glycerine prevents the wick becoming dry and hard, a condition in which it is not only apt to irritate, but which greatly militates against its perfect action.

With Toynbee's artificial tympanum, the wire handle

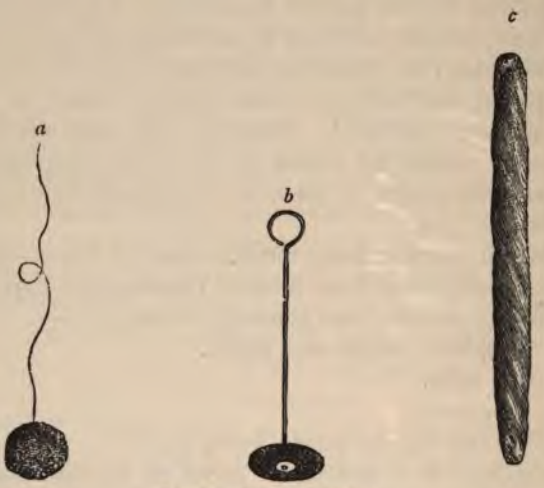

FIG. 38.—Artificial tympana.
a. Yearsley's (cotton-wool). *b*. Toynbee's. *c*. The wick (cotton-wool).

is used to introduce and withdraw the disc, which must be pushed right down to the drum-head. When a thread is substituted for the wire, forceps, or a fine quill (through which the thread is drawn) should be employed for the introduction of the disc.

Various discs made of paper, linen, &c., have been and are used for this purpose, but there is always considerable difficulty in their application and removal.

Mode of action.—It is just possible that artificial tympana act in some small degree as true substitutes for the membrane; that is to say, they help to pick up the sound waves, but their value in this respect can only be infinitesimal. No doubt the improvement of hearing power is almost entirely due to the pressure exerted on the ossicles, especially the stapes; for in this way they are restored to their right position, and the due tension which is necessary for the reception of sound-waves, is given to the whole. The artificial tympanum is therefore only to be regarded as a substitute for the membrana tympani, in so far as the membrane acts as a ligament holding the ossicles *in situ*, and not in respect to its chief function.

FIG. 39.—Forceps for introducing Yearsley's artificial tympanum and the wick.

Advantages.—1. The increase of hearing power, which, whatever may be its *modus operandi*, is of immense value to the patient.

2. The antiseptic and absorbent properties of the cotton-wool employed are in themselves one of the best methods of treating the otorrhœa (p. 154).

3. They form a protection to the otherwise exposed and delicate tympanic mucous membrane.

Precautions to be observed in its application.—As the artificial tympanum requires great nicety of adjustment, and as it is absolutely necessary that the patient should learn to apply it for himself, the surgeon must take great pains to teach him to do so.

Some patients manage in one or two lessons to apply

this artificial aid more perfectly than the surgeon himself, while others will require to be shown a great many times. The ear will not always tolerate this foreign body without shewing signs of considerable irritation, therefore the patient should be cautioned not to wear the wick for more than a few hours at first, gradually increasing the time until it can be worn all day long. It is rarely advisable to leave it unchanged for more than 24 hours, and the best plan, perhaps, is to put in a fresh one every morning and take it out altogether at night. Occasionally the patient will experience extra difficulty in successfully adjusting the wick, and is tempted to continue his efforts until irritation is set up. Against this he should be carefully warned. If inflammation should result, the use of the plug must of course be discontinued until all such inflammation has quite subsided.

Cases suitable for its application.—It is most useful where there is a large perforation, particularly if this involves the lower and posterior portion of the membrane, in which case it seems that the larger the perforation the more chance of the artificial aid being of service. It is especially adapted for use when the perforation is kidney-shaped (fig. 35*c*). In cases where the patient notices that his hearing is always considerably improved immediately after syringing, the surgeon may be almost certain to obtain good results from the use of the wick; and, indeed, in no case of considerable perforation should he omit to test its value, except where profuse discharge or any tendency to acute inflammation contra-indicate its use. Occasionally, its careful application will fail to prove beneficial at the first trial, yet if it is tried again after the lapse of a few months, the second attempt may prove successful.

This little contrivance will frequently act as if by magic, and every aural surgeon has come across cases in which the patient, long supposed to be past all aid, has been by its means restored to intercourse with the world.

The most perfect success that I have ever witnessed in connection with this, was in the case of a lady who had been wearing an artificial tympanum on each side for thirteen years. When removed, the hearing distance was only 1 per cent. by my watch, but when the wicks were inserted this was increased to between 60 to 70 per cent. In other words, without these aids she could scarcely hear loud conversation at the shortest distance, whereas by their use her hearing was practically normal; and curiously enough, in her case there was scarcely any part of the membrana tympani remaining on either side.

As a rule the beneficial effect increases as time goes on, and in those very few instances that have come under my notice where the hearing power has decreased, this has been due to the healing of the membrana tympani in such a manner as to interfere with its proper vibration.

CHAPTER IX.

COMPLICATIONS AND SEQUELÆ OF CHRONIC SUPPURATIVE CATARRH.

THE numerous complications which may arise in the course of otorrhœa, not only affect the hearing power, but often endanger the life of the patient. They will be considered under the following heads, viz :—

Granulations and Polypi.
Exostosis.
Loss of ossicles.
Periostitis and ostitis, caries and necrosis.
Facial paralysis.
Mastoiditis.
Cholesteatoma.
Intra-cranial complications.
Pyæmia.

Granulations and polypi. *Pathology.*—I propose to consider granulations and polypi together because of their pathological relationship. They are, in nearly every case, the result of chronic suppurative inflammation alone, or of this condition combined with periostitis.

When arising from the former condition, the tendency is to gradually develop from granulation tissue to soft fibroma, or, further, to dense fibroma, and this again may go on to ossification.

If there is not much increase in size, the condition never passes beyond that of granulations or a granulating surface, but tends finally to produce a layer

of fibrous tissue which may fill up a portion of the tympanic cavity. This will leave a cushion of newly formed fibrous tissue adherent to the inner wall of the tympanum, and in some cases adherent on the outer side to the remnants of the membrana tympani. I may here remark that this is a very unfavourable condition as regards the hearing power.

When, on the other hand, the granulation enlarges, a polypoid tumour or polypus is the result. This may grow larger and larger until it fills up the meatus, and may even protrude from the external opening. These polypi pass through the histological stages already described. They are covered by a layer of mucous membrane, with epithelium corresponding to that of the surface from which they have grown. Thus we may have them covered with columnar ciliated epithelium, or with the stratified squamous variety. They are well supplied with blood-vessels, which sometimes increase to such an extent as to bring the tumour under the class of angioma. Occasionally clefts and cavities lined with epithelium are found in polypi, these cavities being due to union of the margins of two epithelial surfaces, leaving a space between.

Soft, rapidly-growing granulations or polypi are almost always to be met with in the course of periostitis, caries or necrosis. They correspond exactly to the fungating granulations found around diseased bone in other parts of the body, and rarely pass beyond the stage of soft fibroma unless the ostitis becomes very chronic.

From the foregoing pathological history of polypi, three forms of this tumour will have been accounted for; namely:—

1. Soft fibroma.
2. Dense fibroma.
3. Angioma.

Sarcomata and epitheliomata in this region are apt to assume a polypoid form and to be mistaken for ordinary benign polypi. But malignant growths in connection with the meatus are comparatively rare, whereas granulations and polypi are very common forms of ear disease.

Early authorities were in the habit of dividing polypi into false and true, according to whether they were soft or firm; the false therefore corresponding to the soft fibrous polypi, and true to the dense fibrous ones.

Diagnosis.—Unless there has been pre-existing otorrhœa, the occurrence of polypi and granulations is practically impossible; on the other hand, their presence may be confidently predicted whenever blood is found mixed with the discharge in a case of otorrhœa.

To discover granulations and the smaller polypi, the meatus must be carefully cleansed, either by syringing or drying out by means of cotton-wool mops;* then the speculum and a good light will reveal their presence. It is often impossible to diagnose between a small polypus and a granulating surface by these means alone, but the use of a probe with flattened end will soon decide the point, for if this can lift up or pass round the mass, it must of course be a polypus. Granulations and the smaller polypi are almost always of a bright red colour, but they assume a paler tint when developed into fibrous tissue.

* These are made by twisting a little absorbent cotton-wool round the end of a cotton-holder. The best form of holder is an ordinary probe, the rounded end of which has been filed flat; this flat end readily twists up the wool and yet allows the mop to be easily slipped *off after use.*

Polypi may also be mistaken for exostoses, but the hardness of the latter when felt with a probe, makes it an easy matter to distinguish between them (p. 92).

Again, we sometimes, although very rarely, have to do with a sebaceous tumour which, projecting from the wall of the meatus, bears a resemblance to a polypus; but in such cases there is rarely any discharge, and by its appearance as well as by application of the probe, a correct diagnosis is easily made.

When the polypus comes near to, or projects from the opening of the meatus, it may be mistaken for a furunculus, especially as the surface of these polypi is often pale like the skin. A probe passed round the tumour will, however, at once resolve the difficulty.

A polypoid outgrowth of epithelioma may sometimes be taken for an ordinary polypus. Although with the former we also get purulent discharge, very often containing blood, and it is a distinct polypoid growth, yet it may be distinguished by the age of the patient, usually past middle life; by the cachexia; by the rapid growth of the tumour, especially after partial removal; by its brittle nature; by the peculiar hard finely nodular feeling imparted to the probe; and by the intense pain produced by the tumour itself. These are usually sufficient data to enable us to form a correct diagnosis, but the matter should be made more certain by the microscopical examination of a portion.

There may be some difficulty in diagnosing between a benign polypus and a polypoid sarcomatous growth in the earlier stages. Even the microscopical appearances may be misleading for instance:—in conjuction with Mr. Marmaduke Sheild I was consulted in a case in which such a growth had been removed from the meatus of a young lady; microscopically the appearance was

that of an ordinary spindle-celled sarcoma, but the polypus was growing from a carious surface, and shewed no tendency to return after the carious surface had been thoroughly scraped. On the other hand there can be no doubt that sarcoma may develop from what, both clinically and histologically, had at first every appearance of being an ordinary polypus. Of course as the tumour enlarges there is less uncertainty about the diagnosis; the dull pain, the scanty, foul discharge, the tendency to severe hæmorrhage and rapid re-growth after attempts at removal, the implication of the cervical glands and the appearance of constitutional symptoms all unmistakably point to the malignancy of the disease.

It is important to distinguish between the ordinary slow-growing polypi and those of acute inflammatory origin, on account of the difference in the treatment, as will presently be seen.

Treatment of granulations.—When granulations are abundant, it is far better to remove them with the curette (p. 176), but if they are small this is not necessary.

By caustics, etc.—Various caustics have been used for the purpose of destroying granulations; as nitrate of silver, chloro-acetic acid, chloride of zinc, chromic acid, and perchloride of iron.

Nitrate of silver.—This should be used either in the form of a strong solution (gr. 30 to 1 oz.), applied by means of a cotton mop at the end of a probe or cotton holder, or in the solid state. For the latter purpose the following will be found a very practical method. Heat the rounded head of a probe to redness in the flame of a spirit lamp, and plunge it into some powdered nitrate of silver; on withdrawal, a bead of nitrate of silver will be found fused on the point, and this may be readily *applied through* a speculum to the granulations.

This caustic answers well for granulating surfaces and small granulations, but its action does not penetrate deep enough to make it of value when they are more abundant.

Chloro-acetic acid and chloride of zinc are strongly recommended by some aural surgeons, but I prefer the following:—

Chromic acid.—I have always found this the best form of caustic whenever penetrating power is required. It passes deeply into the tissues, and thus destroys granulations and even small polypi. It should be fused at the end of a probe in the same manner as just described for nitrate of silver, except that the probe does not require to be so strongly heated. In this way the chromic acid may be applied through the speculum to the exact point where it may be required.

The galvano-cautery.—This is a very useful means of destroying large granulations, but requires considerable care.

By astringents, stimulants, and dehydrating agents.—Powdered burnt alum applied to the cleansed surfaces makes an excellent astringent, but it has the disadvantage of caking and thus forming a mass that may be difficult to remove. Powdered acetate of lead was at one time much recommended, as was also tannic acid, but these have now all given way to alcohol, which undoubtedly yields the best results, except when the granulations are accompanied by acute or sub-acute inflammation. The alcohol should be used as already described (p. 152). Perchloride of iron is a very useful astringent, especially when there is a marked tendency to hæmorrhage. It may be used as an adjunct to alcoholic instillations (Tr. Ferri Perchlor. ʒj., to Sp. Vini Rect. ʒij.); or applied by means of a small cotton-wool mop, either

in the form of the anhydrous powder, or Sir James Simpson's saturated solution in glycerine (See Appendix).

Granulations with acute or sub-acute inflammation are best treated by counter-irritation (*i.e.*, blisters behind the ear), together with the application of nitrate of silver.

In all cases the otorrhœa must be treated as well as the granulations.

Treatment of polypi.—Ordinary polypi should be treated first by removal, and secondly by destruction of the stump and of the unhealthy surface upon which they

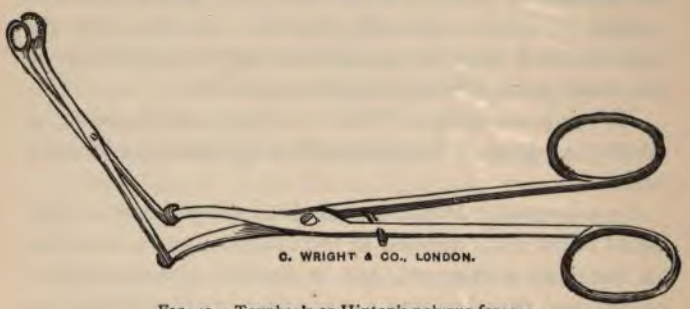

FIG. 40.—Toynbee's or Hinton's polypus forceps.

may re-form. This second step is most important, as without it a polypus is sure to grow again.

Removal.—Simple syringing will occasionally remove a polypus, but this is rare, and cannot be depended upon.

Torsion by means of forceps or snare.—This consists in seizing the polypus as near the base as possible, either with some kind of forceps, or by means of a wire snare, and then twisting it round and round until it is torn off. Numerous forceps have been devised for this purpose; I prefer Toynbee's or Hinton's ring forceps (fig. 40).

Strangulation.—Instead of twisting the polypus sufficiently to tear it off, it may simply be twisted enough to produce strangulation, and thereby death of the tumour, which will then come away in a few days as a slough. This treatment is most appropriate when the pedicle is

FIG. 41.—Polypus snare.

very strong, and when the surgeon fears that the parts surrounding it may be injured by torsion.

By the snare (fig. 41).—The snare may be used to cut through the pedicle instead of torsion, and, although this does not remove the tumour so completely, it is a favourite method with many surgeons. I prefer it

in those cases where the polypus is large but soft, and especially for such inflammatory polypi as it is advisable to remove. Soft iron wire should be used for the snare; and before the loop is introduced into the meatus the wire should be bent at right angles, so as to slip easily on to the growth.

By the curette.—This is a very valuable instrument for removing small polypi. I prefer the one recommended by Burckhardt-Merian, although of course the exact form is not of much consequence. Under good illumination the oval ring is passed over the polypus, and on withdrawal the sharp edge cuts through the pedicle. The introduction of this instrument causes very much less pain than the forceps.

By breaking up.—Frequently the polypus is so soft that removal *en masse* is impossible. It must then be broken up by means of forceps or curette.

By destroying vitality.—Occasionally a firm polypus with a broad base presents difficulties in removal by any of the above means; its vitality must then be destroyed. Chromic acid or some other penetrating caustic should be inserted right into the centre of the tumour, which will then die and come away in a few days in the form of a slough.

Of all the above methods, that by torsion or by the curette will be generally found the most practical.

In my own practice the routine which I have found most satisfactory is as follows:—

For three or four days before the operation the ear is well syringed out, three times daily, with carbolic lotion (1 in 40).

A few hours before, the meatus and the auricle are purified by being thoroughly washed, and scrubbed with carbolic lotion (1 in 20) a few drops of

which should be instilled into the deeper parts of the meatus for ten or twelve minutes; a strip of cyanide gauze wrung out of 1 in 20 carbolic is then lightly plugged into the meatus, and a compress of the same applied over and round the auricle (in children, and in adults with delicate skins, 1 in 40 should be substituted). This compress is not removed until anæsthesia has been induced.

On removal of the gauze the parts are again washed and syringed with 1 in 40, and this is also freely used for the removal of the blood and debris that may accumulate in the course of the operation. The strictest antiseptic precautions are observed as to the instruments, the surgeon's fingers, and everything that is brought in contact with the parts. The polypus or granulation being removed, its base is well curetted, and any carious spots thoroughly scraped. After a final syringing with 1 in 40, a plug of cyanide gauze well wrung out of 1 in 40 is lightly packed down upon the affected area, and the auricle and adjacent parts covered with the same material, the whole being kept in position by means of a pad of salicylic wool and a bandage.

By adopting these precautions I have found that, as a rule, the dressing only requires to be renewed every second or third day, and very often the case is entirely healed within seven or eight days. Even in the few cases in which the otorrhœa does not promptly cease, and in which the surgeon has to resort to the ordinary methods, *i.e.*, frequent syringing, alcoholic instillations &c., the treatment will be much shortened by this antiseptic method of procedure. In some cases a slight sero-mucous discharge remains, which may require a few instillations of alcohol before it entirely disappears.

It is obvious, of course, that mere aseptic precautions can be of no real value in dealing with such highly septic cases as these.

As a rule it will be found of advantage to have the patient well under the influence of a general anæsthetic. The operation is one of considerable delicacy, and the least movement on the part of the patient is apt to throw the meatus into shadow, making it extremely difficult to get a good hold of the polypus at the first attempt, and unless this is done the hæmorrhage from the injured tissues completely obstructs the view. When the polypus is a small one cocaine may suffice; a pledget of cotton-wool soaked in a twenty per cent. solution should be kept in the meatus for ten or fifteen minutes beforehand. Under ordinary circumstances, however, it appears probable that solutions of cocaine are not readily absorbed by the cutaneous surface of the meatus, and do not penetrate sufficiently into the substance of the polypus itself, so that the anæsthesia produced is very imperfect.

Exostosis.—On referring to page 91 it will be seen that a kind of multiform exostosis occasionally results as a complication of chronic otorrhœa. This is produced in some cases by the ossification of small polypi, in others by an outgrowth of bone from chronic periostitis.

Disease and loss of ossicles.—In cases of considerable destructive disease of the tympanum generally, or where the attic is alone affected (p. 149), one or more of the ossicles may become detached and lost. This may take place through the loosening of their attachments and destruction of the blood supply, resulting in necrosis *en masse*. Caries not infrequently affects the malleus and incus, and this may cause erosions

of the heads or processes, and sometimes ankylosis of the two ossicles. This carious condition accounts for many cases of attic disease being so difficult to cure until the offending ossicle comes away, or is removed by operation.

The incus is the bone most frequently lost, as might be anticipated from its less strong attachments and more restricted blood supply.

The malleus does not often disappear, because it is attached firmly to the membrana tympani, through which it receives ample nourishment. So long therefore as a remnant of the upper part of the membrane remains, this ossicle need not be lost; and as a matter of fact, we often find that the handle of the malleus is a prominent object in those cases where scarcely any of the membrana tympani is left.

The stapes rarely comes away, but if this should happen, the function of the internal ear is almost invariably destroyed, as the loss of the oval plate forming part of the wall of the vestibule (p. 18), allows the epilymph contained in the labyrinth to escape.

The loss of the whole of the membrane and the two first ossicles, need not involve anything like complete deafness, provided that the stapes is *in situ*, that the stapedius muscle is intact, and that there are no adhesions causing fixation of the stapes.

In a typical case of this kind which came under my notice at the Royal Ear Hospital, the patient, a lawyer's clerk, had sufficient hearing with the affected ear (which, moreover, was the better of the two), to carry on his ordinary duties; on measuring, I found his watch-hearing power to be one-fourth of the normal.

Periostitis, ostitis, caries and necrosis.—Some amount of periostitis and ostitis almost always accom-

panies acute inflammation of the tympanum. This is much more marked when the osseous portion of the meatus is involved, because of the intimate connection between the periosteum and skin (p. 8); in such cases inflammatory polypi are very frequent. These must be treated in the same way as other cases of acute inflammation of the tympanum and meatus; and blisters over the mastoid, kept open if possible, will always be found of great service when periostitis exists.

Chronic inflammation of the periosteum and bone is a frequent complication of chronic otorrhœa, and is specially liable to occur in patients of a tubercular tendency. This renders the condition much more difficult to treat and more tedious in its course, while the prognosis becomes graver on account of the increased danger to the meninges and brain. When the inflammation passes on to caries or necrosis, the progress of the case becomes much slower, and the prognosis still more unfavourable.

Diagnosis.—When periostitis is unaccompanied by caries or necrosis, the diagnosis may be very difficult; the presence of granulations, and the obstinacy in healing being the signs mainly to be depended upon. But the task is easier when caries or necrosis exist. The discharge is then grey or brown, fœtid (even when the ear is kept well syringed) and slightly tinged with blood, and it occasionally contains small gritty particles of dead bone. The granulations are more abundant, and indeed will frequently surround the carious spot or necrosed portion, and any uncertainty in the diagnosis will be resolved if, on inserting a probe, bare bone is felt. So that whenever a mass of granulations is seen, search should be made by means of a probe, for a *carious* spot. I need scarcely say that the probe should

be used with caution whenever its point is out of view. Again, the speculum may reveal the necrosis itself.

The portion most liable to necrosis is some part of the vaginal process which forms the wall of the bony meatus, but any part of the petrous or mastoid bone may be so affected, and pieces of considerable size have been known to come away through the enlarged meatus. Sometimes the cranium itself may be perforated by this means, so that the dura-mater is laid bare. In all these cases there is great danger of meningitis and pyæmic infection.

Treatment.—In this disease the use of alcohol, chromic acid, and other strong irritants is contra-indicated. Rapid healing by means of boric acid powder is unwise in many cases, for occasionally, if the surfaces are healed and the discharge stopped rapidly, disease of some neighbouring portion of bone will break out. Therefore the slower modes of healing are to be preferred.

Whenever the carious surface is within reach, it should be thoroughly scraped with a sharp spoon, the same antiseptic precautions being adopted as recommended in the removal of granulations and polypi (p. 176).

In other cases frequent injections of carbolic acid and zinc are very suitable, and when the ear will bear it, I often make use of dilute nitric acid ($\frac{1}{2}$ per cent. solution, to which some carbolic acid has been added, see Appendix) with marked benefit. The nitric acid partially dissolves the carious particles, which are thus got rid of more easily. Again, it is sometimes useful to mop out the carious cavity with a solution of nitrate of silver (gr. 40-ʒj).

If a carious cavity is found to be filled with caseous,

or with the so-called cholesteatomatous material, this requires to be very carefully removed by syringing, &c., before local applications can be made to the carious surface.

In sub-acute cases it is rarely advisable to scrape the carious surfaces, but for the granulations and inflamed polypi which frequently accompany this condition, the solid nitrate of silver fused at the end of a probe (p. 172) should be freely used, and must be repeated from time to time. If the polypi become large enough to interfere with the due exit of pus, they should be removed by means of a snare. Counter-irritation over the mastoid, especially by blisters kept open, will prove very useful.

When necrosis takes place, the necrosed portion should be removed by means of forceps, assisted sometimes by syringing, as soon as the dead bone is sufficiently loose to come away readily; but from the important relations of the auditory apparatus, it is obvious that in this region the sequestrum cannot always be removed so early as it might be in other parts of the body, so that the course of necrosis here may be extremely tedious.

Again, the size and shape of the sequestrum may be such as to render its removal extremely difficult, even when it is quite separated. In these cases dilute nitric acid injections, as already recommended (p. 181) will sometimes prove of much service by decalcifying the sequestrum, and thus softening the prominent spiculæ which interfere with extraction.

General health.—As disease of the bone usually occurs in debilitated patients, and may be very tedious in its course, careful constitutional treatment is always necessary. The diet should be of the most generous kind,

aided by alcoholic stimulants, moderate in quantity and taken with the food; and sea-side residence, or at least good country air, is almost indispensable. When advising a residence at the sea-side, the patient must be warned against bathing in the sea, lest the sea-water should get into the ear and set up acute inflammation which might prove fatal. Tonics, such as the mixed phosphates, phosphates of iron, quinine, strychnine, &c., together with cod-liver oil, are generally of service.

Prognosis.—This is very much graver than when the otorrhœa is unaccompanied by disease of the bone; but still the prognosis is not so serious as at first sight it would appear to be; for Nature, with her customary foresight, gradually forms a bulwark around the diseased part with organised lymph, thus cutting it off from the deeper and important tissues. Indeed cases have been known where almost the whole of the petrous bone and even the whole of the temporal bone* has come away in the form of a sequestrum, and yet the patients have made a good recovery as far as the disease itself was concerned. But this reparative tendency is much impaired as life advances, and hence in elderly people the condition is infinitely more serious. It must be admitted, however, that recent methods of treatment have considerably diminished the gravity of the prognosis.

The dangers to be apprehended are, acute inflammation rapidly extending to the cranial cavity, meningitis, pyæmia and abscess of the brain, which will be presently considered.

* Case reported by Sir William Dalby. "Transactions of the Royal Medical and Chirurgical Society," vol. lxii., p. 240. Specimen now in Museum of St. George's Hospital.

Facial paralysis.—Facial paralysis, or in other words, paralysis of the portia dura, occasionally takes place during the course of suppurative disease of the ear.

The liability to implication of this nerve will be readily understood when its relations to the tympanum are taken into account. It must be borne in mind that the aqueductus Fallopii, containing the nerve, is first an inner and then a posterior relation to the tympanum; so that inflammation readily extends from the tympanum to this tube, and the inflammatory exudation pressing upon the nerve will then produce the very characteristic facial paralysis. If the pressure extends as far as the origin of the great petrosal nerve, paralysis of the uvula will also be noticed; and when the disease is so extensive as to destroy the nerve itself, permanent facial paralysis will result, and no treatment will be of any avail.

Fortunately, however, the mischief is usually but partial, and the nerve recovers its function as the parts become healthy. Repeated blistering behind the ear will frequently relieve the pressure on the nerve, and thus aid in restoring its function. Again, after all the inflammatory symptoms have passed away, galvanism (faradisation) will sometimes prove beneficial.

Facial paralysis occurring in mastoid disease of young children, especially if in the early stages, is a very unfavourable sign, as it usually indicates tubercular disease of the bone.

CHAPTER X.

COMPLICATIONS AND SEQUELÆ OF CHRONIC SUPPURATIVE CATARRH—(*Continued*).

MASTOIDITIS.

MASTOIDITIS, or inflammation of the mastoid process, is a complication of suppurative inflammation of the tympanum, but the condition is so serious that it requires a more detailed description. It may be divided into *superficial* and *deep*, according to whether the inflammation involves merely the surface or the substance of the bone.

Superficial. *Pathology*.—Occasionally during the course of inflammation (more especially suppurative inflammation) of the deeper portion of the meatus, the disease extends through the gap left in the roof of the bony meatus by the incompleteness of the vaginal process in this position (p. 8), from thence it passes along the fissure between the vaginal process and the mastoid bone, and thus, getting under the periosteum, makes its appearance on the mastoid process itself. Sometimes this inflammation spreads upwards and forwards to the temporal fossa, producing swelling and deep-seated fluctuation in this position.

In some few instances the œdema is excessive, and involves not only the tissues over the mastoid process itself, but also the adjacent parts of the neck; in these cases, although there is every indication of deep-seated

pus, yet on free incision none is found, nor does suppuration occur if proper antiseptic precautions are observed. This condition may be termed *œdematous mastoiditis.**

Diagnosis.—The signs of acute superficial mastoiditis are exceedingly characteristic, but it must not be forgotten that it is often associated with, and dependent upon inflammation of the substance of the bone. A glance at the back of the patient's head, shows that the auricle on the affected side stands out more prominently than that on the other. There is considerable redness and swelling over the mastoid process which pits on pressure, and is generally very tender. If pus has been already formed, fluctuation, more or less deep-seated, may be felt. This condition is usually accompanied by considerable febrile disturbance, and much pain.

Treatment.—An early incision down to the bone right through the periosteum should always be made, as insisted on by the late Sir William Wilde; this, in the early stage, relieves tension, and directly depletes the inflamed parts. In the later stages, when pus has been formed, the incision provides an exit, and thus prevents burrowing, which, by separating the periosteum, occasionally causes exfoliation of the bone beneath.

Previous to performing this operation, the surgeon must carefully define the tip of the mastoid process, so as to avoid the danger of wounding the important structures situated below it. The incision should be vertical, an inch or more in length, and about ½ an inch behind the auricle. In doing this

* Two such cases are reported in the "King's College Hospital Reports," 1893-4, vol. i., p. 295.

the surgeon will often be astonished at the depth he has to penetrate before reaching the bone, and this may somewhat disconcert him. I have known a case where the surgeon feared he had opened into the cranium, and mistook the thick pus for softened brain matter. Again, as a rule, the posterior auricular artery is divided, and smart hæmorrhage is the result. This need not create alarm, nor should it be arrested, save in very exceptional cases, because it will usually be found that the smarter the hæmorrhage the greater the relief.

When the temporal fossa is also implicated, the incision should be made a little higher up, but still behind the auricle. This will give sufficient exit for the pus or serum, for occasionally, as in œdematous mastoiditis, the fluid is serous and not purulent. The incision must be kept open by means of a drainage tube, or by the daily introduction of a probe. After the incision, light pressure in the form of a pad over the temporal fossa will prevent the cavity from refilling, and will accelerate the healing process.

Some surgeons advise cold applications in the treatment of mastoiditis, but I am very averse to these. Again, leeches behind the auricle are often employed, but this method of depletion is not nearly so effective as the incision. A smart purgative, light diet and perfect rest are to be prescribed; ten grain doses of antipyrin will frequently be found of service in relieving the pain.

Deep mastoiditis.—Occasionally, in the course of acute or chronic suppurative inflammation of the tympanum, the air-cells of the mastoid process become affected by extension of the disease through the antro-tympanic cavity. Or the disease may be conveyed,

more or less directly, to the mastoid cells, by the canals in the posterior wall of the osseous meatus (p. 8). Or, lastly, in a few cases, especially those resulting from epidemic influenza, the cells themselves are primarily affected.

Course.—In quite mild cases the inflammation may stop short of actual suppuration, and resolution may then take place; but as the infection is septic the tendency is towards the formation of pus. What usually occurs is, that the bony trabeculæ between the mastoid cells break down, so that the antrum and adjacent cells form one continuous cavity containing pus, softened bony débris, and granulation tissue. The size of this cavity varies, of course, according to the type of mastoid formation (p. 17); for instance, it is apt to be largest in the pneumatic and pneumo-diploëtic types. If the disease progresses beyond this stage, perforation occurs in the bony wall of the cavity thus formed, and the direction in which this perforation takes place is again largely determined by the character of the mastoid formation; for instance:—

1. If the original mastoid cells were large and approached the surface, the perforation is apt to take place in the outer surface of the process, and an abscess is formed behind the auricle, simulating superficial mastoiditis. When this abscess opens through the integument, a sinus is formed through which fluids can be injected into the tympanum and meatus.

2. Travelling directly backwards, the disease may cause a perforation of the vertical portion of the groove of the lateral sinus, and so give rise to an extra-dural abscess in the posterior fossa of the cranium.

3. In the sclerosed type of formation the tendency *is for* the perforation to take place in a direction up-

wards and inwards, opening into the middle fossa of the cranium, and so forming an extra-dural abscess.

4. Finally, the perforation may occur at the tip of the mastoid process, on the inner wall, (Bezold's perforation). The presence of the deep cervical fascia then causes the pus to burrow downwards into the posterior triangle of the neck, and inwards towards the pharynx, where a post-pharyngeal abscess may result.

Openings into the cranial cavity add to the gravity of the prognosis very considerably, as there is then obviously more danger of thrombosis in the lateral sinus, pyæmia, meningitis and intra-cranial abscess. In the so-called Bezold's perforation the case is often very long and tedious; the formation of an external opening (type 1) is the most frequent and most favourable of all terminations, and it is in fact towards encouraging this form of opening that the efforts of the surgeon are chiefly directed.

Facial paralysis is sometimes a complication of mastoid disease, especially in tubercular cases, for which reason, and particularly in young children, this complication is usually looked upon as a bad sign; no doubt facial paralysis would occur more frequently than it does, were it not for the fact that the walls of the Fallopian aqueduct (containing the facial nerve) are composed of tolerably thick compact bone.

Diagnosis.—Acute deep mastoiditis is characterised by intense deep seated pain, with tenderness over the mastoid process, especially when the part is percussed. There may be little or no swelling of the superficial tissues, but frequently the whole of the outer bony wall is involved, and then we have all the signs of superficial mastoiditis already described. Should a sinus have formed, a probe passing into the substance of the pro-

cess will practically complete the diagnosis. In these acute deep-seated cases the febrile disturbance is more marked than in the superficial ones, and is much more likely to be associated with some signs of intra-cranial mischief.

In many chronic cases the diagnosis is far from easy, and in fact, sometimes, it is only after the case has been watched for some few weeks, that we can form a definite opinion. The signs and symptoms characteristic of the chronic disease are:—1. Deep-seated pain and tenderness in the mastoid region are nearly always, though not invariably present; the pain is often referred to the upper part of the squamous portion of the temporal bone, or runs forwards or backwards along the course of the nerves. 2. The temperature is usually more or less raised, though occasionally it remains normal. 3. The discharge from the meatus is frequently very profuse, brownish in colour, and fœtid, and does not yield to the most rigorous antiseptic treatment. 4. The posterior wall of the meatus, especially in the deeper parts, is often red, swollen, and prolapsed, as it were, into the canal. This sign, together with the persistence of the profuse, fœtid discharge, I take to be the most suggestive of chronic deep mastoiditis. 5. Facial paralysis, if present, will serve to corroborate the diagnosis. 6. Signs of meningitis, pyæmia, or intra-cranial suppuration will, of course, remove any doubt as to the exact nature of the disease. In doubtful cases it is not only permissible, but advisable to make an exploratory Wilde's incision, and examine the outer surface of the mastoid bone itself.

Treatment.—In the milder cases referred to above, a smart purgative, together with Wilde's incision or counter irritation over the mastoid in the shape of blisters,

leeches, hot applications, &c., are indicated, and will promote resolution. But when the case has passed beyond this stage, and the surgeon is satisfied that suppuration has actually taken place in the antrum or mastoid cells, then opening up these cavities is imperatively called for, even although the exact extent of the disease is uncertain.

The Mastoid Operation.

Before commencing to describe this operation in detail, it will, perhaps, be as well to recall to mind the anatomical relations of the parts. The most important of these relations are as follows:—Superficially, the operation-area is limited in front by the auricle and the cartillaginous portion of the meatus, and below by the soft tissues of the neck. Deeply, the relations are more important; anteriorly, we have the wall of the osseous meatus, with the facial nerve; directly behind, is the groove of the lateral sinus, which at this point assumes a vertical direction; above, the middle fossa of the cranium is separated from the antrum by a plate of bone which is often exceedingly thin; below, are the large vessels and nerves of the neck. Bearing these relations in mind, it is obvious that the proximity of these structures to the mastoid process, renders what would otherwise be a very simple operation, one of considerable delicacy and difficuly. Moreover, these difficulties are occasionally enhanced by irregularities in the conformation of the skull. For instance, the groove of the lateral sinus may sink so deeply into the mastoid process, as to leave very little bone between it and the posterior wall of the osseous meatus; again,

the process may be encroached upon from above, by an unusual dipping down of the middle fossa of the cranium. In either of these conditions it may be impossible to reach the antrum, without at the same time opening the cranium in the course of the operation.

There can be no doubt that the success which has attended these operations of late years is due, in great measure, to the introduction of antiseptic methods, which should, therefore, be adopted in all cases; as we have to deal with suppurative bone disease, mere aseptic precautions must necessarily be quite unreliable. In some few instances the operation is one of emergency, and little or no time for preliminary preparation is obtainable; but when this is not the case, the auricle and the meatus should be rendered as aseptic as possible, in accordance with the directions given on p. 176, and in addition a compress of gauze wrung out of carbolic lotion (1 in 20) should be applied all over the mastoid and adjacent temporal region, for about six hours beforehand.

The patient being anæsthetised, the hair within a radius of two or three inches of the auricle is shaved, and the surface thus laid bare is very thoroughly scrubbed with soap and carbolic lotion (1 in 20); the head surrounded with a wet towel wrung out of one in twenty, and a similar towel is placed over the shoulders and neck.

A vertical incision is now made close behind the ear, commencing on a level with the upper margin of the auricle, extending to the tip of the mastoid process, and being carried throughout its whole length right down to the bone; the hæmorrhage, which may be profuse, especially at the angles of the wound, is controlled by means of forceps and pressure. The periosteum is then

detached, so as to permit of the whole surface of the bone being thoroughly examined as far forward as the meatus. If a soft spot or sinus is detected, this is at once opened up with a sharp spoon; if necessary, the outer surface of the process must be removed with bone forceps, chisel, &c., in order to allow of the thorough scraping away of the whole of the underlying diseased tissue in the mastoid cells, and to secure subsequent free drainage. In many cases the process itself will thus be left as a mere shell of dense bone.

The next point is to ensure the free opening up and clearing out of the antrum. In the course of hollowing out the mastoid process in the manner and to the extent indicated above, the antrum is usually opened from below and behind, and to be certain that this is the case, it should be possible to pass a bent probe from the anterior-superior angle of the wound in the process right into the antrum and thence into the attic. In any event, the external wall of the antrum must be removed, the antrum itself thoroughly scraped out and rendered as aseptic as possible by the free use of carbolic lotion.

If, as is not uncommonly the case, no diseased spot can be detected upon the surface of the mastoid process, we proceed at once to open the antrum from outside. The best practical external guide for the situation of the antrum is furnished by feeling for the slight depression directly behind the bony meatus, which itself is easily recognized by its prominent upper margin. Taking this point as a guide, the object of the surgeon should be to remove the whole of the external wall of the antrum, and it is because of the very varying structure and thickness of this wall, and the frequent small size of the antral cavity itself, that extreme care

has to be taken to remove the bone layer by layer; and, therefore, in sclerosed cases this stage of the operation is apt to be very prolonged and tedious.

I prefer myself to work with the mallet and chisel, using a rather broad one (7 or 8 millimetres) at first, when the superficial surface is being removed, and a narrower one (4 to 5 mm.) as the depth increases. In either case the chisel, applied almost horizontally, is tapped very lightly with the mallet, so that only very small thin layers of bone are removed at a time, and only the least possible force is employed. The wound should be kept well illuminated, and from time to time a probe should be passed, to ascertain whether we have opened up a communication with the antrum or mastoid cells, when we must proceed even more carefully, using a hand gouge, a sharp spoon, or bone forceps. The shape and size of the opening is a matter of some importance. It should be oval from above downwards and cone-shaped from without inwards. The long axis of the oval should be vertical, extending from the level of the upper margin of the bony meatus to half way down the mastoid process; the apex of the cone should be at the antrum. The lower wall of the cone should slope a good deal more than the upper; and there should be a tendency for the whole cone to slope forwards, so that the anterior wall runs parallel to, and in the direction of the posterior wall of the bony meatus, leaving a bridge of bone between the two.

Instead of using the chisel, Professor Macewen and Dr. Barr employ a dental engine to drive a large burr, which is applied with alternating pressure to the bone. By directing a strong light into the wound, the proximity of the lateral sinus and cranial cavity is easily

detected. These surgeons consider this method to be of particular advantage in sclerosed cases.

If any doubt exists in the mind of the operator, as to the possibility of clearing out, by the above means, all the diseased bone and septic material in the antrum and attic, it is advisable to break down the bridge of bone left between the meatus and the wound in the process, and so convert the opening in the mastoid, the antrum, the attic, the tympanum, and the meatus into one large continuous cavity. To do this it may be necessary to dissect out the cartilaginous meatus and detach it from the osseous portion, and to pass a probe as a guide into the tympanum through the attic. This modification is usually called Stacke's operation, but strictly speaking Stacke commenced his operation by opening up the antrum through the posterior wall of the meatus, and not primarily through the process, as described above.

When the excavation has been completed and the whole of the disease scraped away, the next point is to establish a free passage between the meatus and the wound, through the tympanum and the attic, so that carbolic lotion (1 in 40) injected into the meatus may flow freely out of the wound. If there is only a small perforation in the membrane, this free passage may not be possible, and it may therefore, be necessary to enlarge the perforation or even remove the ossicles (malleus and incus). On the other hand, in some few cases, as for instance when we can be quite sure that the tympanum is free from disease, this free passage is not essential. Both the wound in the process and the meatus itself are now packed with cyanide gauze wrung out of 1 in 40, and the whole covered with gauze and salicylic wool in the ordinary way.

A word must now be said as regards the complications which are likely to arise in the course of the operation. In making the primary incision care must be taken that the knife does not slip off the tip of the mastoid process, and wound the important structures that lie deep down in the neck. The hæmorrhage which follows the incision, though profuse, need not cause alarm, and is easily controlled by pressure, &c.; at the upper and lower angles of the wound especially, small arteries are usually divided, and these may be seized with Spencer Wells's forceps. In clearing out the mastoid cells the sharp spoon is invaluable. With this instrument it is difficult to remove or injure any but diseased tissues, and the mere fact that such tissues yield to the spoon is in itself an indication that they are sufficiently disorganised to require removal; and so long as the strictest antiseptic precautions are observed, one need not anticipate any troubles arising from an opening into the cranium. Occasionally, a sequestrum of bone will be found and will have to be removed from the mastoid region. Sometimes an opening into the cranium will appear to lead into the antrum; but when the antrum itself is opened, a probe will touch hard bone all round, whereas, if the cranium has been opened, the tip of the probe will come into contact with the yielding dura mater. The facial nerve runs deep down in the bridge of bone left between the osseous meatus and the wound in the process, and is hardly likely to be touched in the ordinary operation, but when it is found necessary to break through this bridge (Stacke's operation) care must be taken not to injure the nerve; this will be avoided if, at the deeper part, only the upper portion of the bridge is removed. In children the bony meatus is much shorter, and is inclined at a greater angle than in

adults, and moreover, in children there are practically no mastoid cells. As already stated, not too much importance should be attached to the accidental opening of the cranial cavity; in some cases such opening is inevitable if we wish to eradicate the whole of the disease. If the lateral sinus itself is wounded, the opening in the bone should be enlarged sufficiently to permit of the application of pressure, which will readily check the hæmorrhage. Finally, let me re-iterate the injunctions as to the supreme importance of the strictest antiseptic precautions; when such precautions are taken, the operation, though difficult, tedious, and delicate, cannot be said to be particularly dangerous.

In the majority of cases, an operation of the extent and on the principles above described, is necessary. Occasionally, however, we meet with a case so acute in its onset, that there is every reason to believe that the disease has not had time to produce much disorganisation. It is in such cases as these that drilling alone may suffice.

Drilling.—The first steps of this operation are similar to those of the operation already described, (p. 192); the parts should be prepared and rendered as aseptic as possible in precisely the same way, for we always have to contemplate the possibility of being obliged to perform a more elaborate operation in the end. The primary incision should be made in the same position, commencing on a level with the upper margin of the auricle, but it need not be prolonged so far downwards. After the periosteum has been detached, we feel for the depression immediately behind the bony meatus, and at a point about a sixth of an inch behind its posterior wall the drill is applied. The instrument I employ is represented in Fig. 42; I object to the

trephine, as with it one is more likely to wound the lateral sinus, and, moreover, the inner table of the skull does not require to be removed. The drill-head should be moderately broad (about 7 mm. across). In drilling,

FIG. 42.—A. Mastoid Perforator (½ scale). B. Drill-head (full size).

the point of the drill should be inclined rather forwards, so as to follow a direction almost parallel to that of the meatus, and great care must be exercised to ascertain, by the frequent use of the probe, the precise moment at

which the antrum or a mastoid cell is opened, when the probe will pass much deeper than the tip of the drill. When once an entrance has been effected, the opening should be enlarged by means of a sharp spoon or hand-gouge so as to establish a perfectly free communication with the antrum. Lastly, the operator must make quite certain that it is the antrum itself that has been opened, and must be able to pass a bent probe into the attic. If the antrum has not been reached after the drill has penetrated to the depth of half an inch or so, the operation should be completed by means of the hand-gouge and sharp spoon, or, if need be, with the chisel and mallet. In fact, as already stated, we must always be prepared to extend the operation, if there is the slightest suspicion that the disease has caused any considerable disorganisation. The dressing and after treatment of these cases is precisely the same as for the more elaborate operations.

The objections to the use of the drill are, that it is more difficult by this means to remove every particle of the disease if the mastoid cells are at all extensively disorganised, especially towards the tip of the mastoid process; hence there is more after-risk of Bezold's perforation, septic infection of the lateral sinus, intracranial mischief, &c. For these reasons, although at one time it was my usual method, I have now practically abandoned it in favour of chiseling, except under the circumstances to which I have already referred.

After treatment.—It is as well to re-dress the wound about twenty-four hours after the operation, and subsequently every two, three, or four days according to the state of the wound, the condition of the patient, &c.; care being taken on each occasion to maintain the free passage by syringing some antiseptic lotion (1 in 40)

from meatus to wound and *vice versâ*. As a rule, all the purulent discharge rapidly ceases, and the wound becomes, apparently at any rate, quite aseptic. The opening in the bone is allowed slowly to fill up from the bottom; I do not myself think that there is any necessity to maintain a permanent sinus by means of a silver tube or leaden nail, as is advocated by some. When, however, the drill is employed and consequently the opening in the bone is much smaller and narrower, the temporary use of the tube or nail may be advisable.

Results and prognosis.—In acute mastoiditis surgical interference is almost always followed by a remarkable fall in temperature and relief of pain. Any cerebral symptoms that may be present are greatly ameliorated, and, undoubtedly, many patients owe their lives to the timely performance of this operation.

In the ordinary course of events, the disease in the membrane and tympanum heals long before the mastoid wound; the latter may take from one to ten months to granulate up, and by this time, provided that the strictest antiseptic precautions are observed throughout, there is but little danger of secondary infection, and, therefore, no object in maintaining a permanent opening. Very occasionally, a second or even a third operation is necessary; this is the case when, originally, we have not removed the whole of the disease, and more particularly in tubercular cases.

Sometimes, especially in sclerosed cases, no pus is found either in the antrum or the mastoid cells, and yet the same marked relief of symptoms results; on the same principle, apparently, as the relief which so frequently follows the drilling of inflamed bone, even although no abscess cavity is reached, *e.g.*, the head of

the tibia. Another great benefit which may be claimed for the operation is that, should the patient be again subject to an attack of otorrhœa, the disease, if it extends towards the mastoid, will readily make its way along the line of least resistance, *i.e.*, towards the outer surface, and there will be but little danger of intracranial developments.

CHOLESTEATOMA.

This is the somewhat clumsy and objectionable term applied to a curious deposit which, in a few rare instances, is found occupying the antrum and mastoid cells, and to which a good deal of attention has been directed of late. It was first noticed by Toynbee, but his description was not by any means clear; more recently, Lucae, Wendt, Habermann, Bezold* and others, have studied the subject very thoroughly.

The deposit has a characteristic pearly white appearance, and consists of masses of epithelium arranged in layers like an onion, with crystals of cholestrine between the strata. By pressure the deposit tends to cause absorption of the adjacent tissues, and so the mass may make its appearance externally upon the outer surface of the mastoid, or pass internally into the cranial cavity. The tympanum and the attic are sometimes the seat of the deposits, and, of course, wherever situated, their presence sooner or later gives rise to inflammatory irritation.

Authorities differ as to the nature of these deposits. Some look upon them as new growths; others consider that they are merely an extension, through a perforation

* *Archives of Otology*, 1890, vol. xix., p. 232.

in the membrana tympani, of the condition of chronic dermatitis of the meatus to which allusion has already been made (p. 72); others again think that they may arise from either of these two causes. I am inclined to the opinion that chronic dermatitis of the meatus is not only the most frequent, but also the sole cause of the condition. In old-standing otorrhœa there is not only a tendency to chronic localised dermatitis, but at the same time the mucous membrane of the tympanum is much altered; it is obvious therefore, that the extension inwards of the disease from the meatus may easily result in the production of these epithelial masses.

Symptoms and diagnosis.—There are no symptoms which can in any way be said to be essentially characteristic of the disease. The surgeon is usually consulted for what, at first sight, appears to be a case of simple mastoiditis, and it is not until the cholesteatomatous material is actually seen, that one can be quite sure of its presence. If the mass is situated in the tympanum and there is a tolerably large opening in the membrane, the white shiny deposit may be visible through the speculum, or shreds and layers of the cholesteatomatous substance may come away on syringing. When the opening in the membrane is small, the diagnosis is more difficult and uncertain, as it depends entirely upon the character of the flakes brought away with the syringe. When the deposits are situated yet deeper, they cannot be recognized until, in consequence of the mastoiditis excited by their presence, an operation has to be performed, when the masses are discovered filling up and distending the antrum and adjacent mastoid cells.

Treatment.—When, in the course of the mastoid

operation, these cholesteatomatous deposits are found, they must be thoroughly cleared away, and to do this it is often advisable to break down the bridge of bone usually left between the antrum and the meatus (Stacke's operation). As, after the operation, the cavity is allowed to heal up from the bottom, there is little or no fear of a recurrence of the disease. When the disease is situated in the tympanum, not only is thorough cleansing necessary, but we must endeavour to restore the mucous membrane to a healthy condition. This is sometimes a very difficult and tedious task; solutions of nitrate of silver (30 gr. to the ounce) or diluted nitrate of mercury ointment (Appendix, No. 6) are the applications which I usually employ.

Intra-cranial Complications.

Within the limits of this handbook it is obviously impossible to deal at all exhaustively with this important subject; but inasmuch as so many intra-cranial lesions are the result of pre-existing ear disease, a short sketch of some of these complications is necessary.

For the sake of convenience the subject will be considered under the following heads:—

Meningitis.
Intra-cranial abscess.
  Extra-dural.
  Intra-dural.
  Cerebral.
  Cerebellar.
Thrombosis of the lateral sinus.

Meningitis.—Slight cerebral irritation (probably meningitis) frequently accompanies acute inflammation

of the tympanum or its adjacent cavities, and is due to extension of inflammation to the meninges. This is characterised by severe localised headache, referred usually to the temporal or occipital region which may be tender on percussion; by fever with well marked evening rise and morning fall; and if long continued, by wasting of the body generally.

In severer forms of meningitis all the symptoms above mentioned are aggravated, while the fluctuations of temperature are often very marked, sometimes rising 4° or 5° at night, and falling to a similar extent in the morning; severe and prolonged rigors too, are not infrequent.

Treatment.—Absolute rest in bed and perfect quite are indispensable. These alone are often sufficient to allay the irritation and overcome slight cerebral symptoms, but at the same time it is advisable not to trust entirely to them.

A smart purgative should be administered, especially when, as is frequently the case, the bowels are constipated.

Counter-irritation in the form of a blister behind the ear or at the nape of the neck is often of great benefit, relieving the pain and other symptoms. Depletion, by means of leeches or by Wilde's incision, will frequently arrest the disease; and in the somewhat severer forms, drilling the outer table of the mastoid will sometimes reduce the inflammation and cut short the attack.

But if the symptoms are not thus arrested, or if they are very severe, the surgeon should not hesitate, in the presence of marked signs of ear trouble, to open the antrum in the manner already described (p. 191). Further, if, by the time the antrum is reached, we do not feel satisfied that the amount of disease met with is

sufficient to account for the symptoms, an opening must at once be made into the cranium; for the meningitis may be due to the presence of an intra-cranial abscess. Even if no abscess can be found, the opening into the cranium, with the consequent local depletion and relief of tension, is the best possible treatment, and frequently leads to complete recovery. Of course, if the meningitis is of the diffuse variety a fatal termination is to be expected in any event, and there is no real reason to suppose that the operation is at all likely to accelerate death.

Extra-dural or sub-dural abscess.—As already mentioned (p. 188), when the suppurating mastoid cavity perforates the inner table of the cranium, a collection of pus is formed between the dura-mater and the skull, *i.e.* an extra-dural, or as it is frequently called a sub-dural abscess. The two most common sites for these collections in connection with ear disease are:—1. In or near the vertical portion of the groove of the lateral sinus, *i.e.* in the posterior fossa of the cranium. 2. On the superior surface of the petrous bone forming the roof of the antro-attic cavity, *i.e.* in the middle fossa of the cranium. These extra-dural abscesses are the most frequent forms of intra-cranial suppuration, and being more easily reached, are more satisfactorily treated.

Intra-dural abscess.—This is the term applied to the more or less localised collections of pus, occuring between the dura mater and the brain as a result of meningitis. These collections are much less definitely localised than in extra-dural abscess, and bearing in mind their origin, and the difficulty of obtaining access to them, they are of course much more fatal, and cannot be so easily treated.

Cerebral abscess.—The cerebral abscesses which result from ear disease are usually located in the temporo-sphenoidal lobe. They are probably due to direct septic infection; the veins becoming thrombosed, the septic process travels backwards in the reverse direction to the blood current. These abscesses are apt to run a chronic course, presenting but few symptoms for, it may be, two or three months. At almost any moment, however, acute meningitis may supervene, or the increased intra-cranial pressure may result in coma and death. In the earliest stages the diagnosis is often far from easy. The temperature in an uncomplicated case is usually sub-normal and fairly steady. Severe, deep-seated pain over the temporal or occipital region; tenderness on firm pressure in the same regions; localised paralyses; optic neuritis; all these may or may not be present, and to a greater or less degree. But in almost all cases it is very difficult, in the early stages, to diagnose or definitely localise the position of the abscess; and even in later and more acute stages the difficulty of accurate diagnosis is not very much less.

Cerebellar abscess.—This is probably produced in precisely the same way as cerebral abscess; septic thrombosis of the lateral sinus being particularly prone to lead to this complication. The difficulties of diagnosis are even greater than in other cranial abscesses, and it is often by a process of exclusion, rather than by any definite signs or symptoms, that we are led to the conclusion that the disease is situated in the cerebellar region. A considerable collection of pus may in fact be present and yet produce no localising symptoms. Subjects of this condition are apt to die quite suddenly, the abscess rupturing into the fourth ventricle and so causing respiratory and cardiac paralysis.

In all these cranial cases the difficulty of diagnosis is enhanced by the frequent presence of such complications as meningitis, thrombosis of the lateral sinus, pyæmia, &c.

Treatment of intra-cranial suppuration.—Since the great advances which have been made in intra-cranial surgery, chiefly by the adoption of antiseptic methods, a large number of lives have been saved by opening the cranium and evacuating the pus.

As our localising and diagnostic powers are as yet very imperfect, I would lay down the broad general rule that, in operating on these cases, we should proceed from the primary origin of the disease in the antrum, attic, or mastoid cells, tracing the disease in its course towards its results in the cranium, rather than attempt to trephine over the site or supposed site of the abscess. If this latter plan is adopted, not only are we likely to miss the abscess altogether, but even if we should evacuate the pus by this means, some similar trouble will in all probability recur so long as the source and tract of infection remain untreated.

Operation.—The operation for opening the antrum, &c., has already been described (p. 191). If the surgeon feels convinced that the disease has extended inwards into the cranium, then, after the antrum, &c., has been cleared out, the vertical skin incision is converted into a ⊢ shaped one, by making a horizontal cut from the centre of the original wound directly backwards, for about 1½ to 2 inches. The periosteum having been detached, the vertical groove of the lateral sinus is very cautiously opened by means of the chisel and mallet; the sinus itself being carefully examined, and if a thrombus is found we proceed in the manner to be subsequently detailed (p. 209). If on the other hand no clot is

found, the sinus is traced upwards and backwards to its horizontal parts. The surgeon now knows that immediately above the horizontal portion of the sinus is situated the middle fossa of the cranium, while immediately below is the posterior fossa containing the cerebellum. He can, therefore, by enlarging the opening upwards by means of the chisel, the trephine, Hoffman's forceps, &c., expose the middle fossa. While proceeding in this way it may of course happen that an extra-dural abscess is discovered in the neighbourhood of the lateral sinus, in which case the pus must be evacuated, and, after making sure that the cranial opening is sufficiently large to secure free drainage, the operation is completed and the wound dressed. If no such discovery is made, a flexible grooved director is passed in different directions between the dura mater and the skull with a view of searching for an extra-dural abscess in other positions, and, finally, the thin plate of bone forming the roof of the antro-attic cavity should be removed, as this is one of the most frequent sites of extra-dural suppuration. Being now assured of the absence of extra-dural abscess the next proceeding is to explore the cerebrum itself. If a cerebral abscess is present and near the surface, the dura-mater will bulge into the opening in the cranium, and, in proportion to the tension, will be more or less free from pulsation; choosing this spot, a carefully purified hollow needle is cautiously thrust into the brain-substance. If pus escapes, or if a fœtid odour can be detected on the needle, the dura-mater is incised and a trocar passed into the cerebrum in the required direction, and should any considerable quantity of pus escape, as if from a definite cavity, it is perhaps as well to gently syringe through the trocar a saturated solution of boric acid

that has been boiled and cooled. A drainage tube is now inserted in the track of the trocar, the wound closed, the horizontal branch of the incision sutured, and a dressing applied.

If the results yielded by this exploration of the middle fossa are not sufficiently definite to account for the symptoms, it may become necessary to deal with the cerebellum. To do this the cranial opening must be enlarged downwards, so as to get below the level of the horizontal groove of the sinus and the tentorium. Otherwise the proceeding is the same as in the previous case, but of course, far greater care is required in introducing the exploring needle.

The dressing and after treatment of these cases is conducted on similar lines to that employed in the mastoid operation.

For further details concerning these formidable operations the reader is referred to special works on Cerebral Surgery.

Thrombosis of the Lateral Sinus.

As already pointed out, mastoid suppuration may readily give rise to the formation of a thrombus in the lateral sinus; and the clot may extend backwards to the torcular Herophili, or downwards along the course of the internal jugular vein. Of necessity this thrombus is septic, tending to soften and break down, with the production of general constitutional symptoms of pyæmia; occasionally, however, the only result is occlusion of the sinus, with collapse and obliteration of the channel below the seat of the obstruction. Some localised meningitis usually accompanies this condition.

As in all other cranial complications the diagnosis is difficult. Marked rigors; severe pain, stiffness, and swelling of the neck; more or less meningitis; constitutional signs of septic infection; these symptoms when associated with suppurative ear disease are all suggestive of thrombosis of the lateral sinus, but the actual condition of the sinus itself cannot be determined until it has been laid bare and examined.

Although an accurate diagnosis is difficult or impossible, there can be no doubt as to the line of treatment to be adopted if, in the course of an intra-cranial or mastoid operation, we discover that the sinus is thrombosed. The signs of such occlusion are as follows:—the vein is firm to the touch, does not collapse on pressure, and is unaffected by respiratory movements in strong contrast to its compressibility and variation under the influence of respiration when the blood-current is flowing. Then again, from a sinus when it is patent, fluid blood can easily be extracted by means of an hypodermic syringe, whereas, nothing can be drawn out if the needle passes into a clot.

If a thrombus is found, the external jugular in the neck should first be ligatured, and then the lateral sinus freely opened up and the clot scraped away. In removing the thrombus we must first of all proceed backwards towards the torcular, clearing away the clot thoroughly, until the occurrence of free bleeding assures us that we have got quite beyond the thrombosed area; very slight pressure or plugging with gauze usually suffices to stop the bleeding, however profuse. The lower or jugular end of the vein must then be cleared out in the same way, and if necessary by syringing from the sinus through the vein opened in the neck; of course, as the vein is tied below, we have not now to look for the

occurrence of free bleeding. In some few cases, especially when the septic process is far advanced, it may be advisable to dissect out the vein and remove it as far down as the ligature, or even to the extent of its whole course in the neck, but this is obviously a much more formidable operation.

When any of these intra-cranial complications arise the prognosis is always very grave, but it occasionally happens that the apparently heroic measures recommended above will save an otherwise hopeless case.*

Pyæmia.

Inasmuch as untreated suppurative disease of the ear is always septic, the condition may well give rise to constitutional symptoms of septicæmia and pyæmia. This is due to septic absorption, from the ear itself; from the disorganised antrum and mastoid cells; from the thrombosed sinus and internal jugular vein; or more readily still from a small septic clot attached to the wall of the sinus, but not entirely obliterating it. In these latter cases minute septic particles are apt to be washed off by the still flowing blood current, and being carried to the lungs, &c., produce the train of symptoms so characteristic of fatal pyæmia. So long, therefore, as any possible source of infection is allowed to remain, we cannot expect to cure the patient; at best, we can only temporarily relieve his symptoms. This of course points to the supreme importance of systematic

* For a case in point, reference may be made to the Author's paper. "Operations for the relief of Intra-cranial Disease," *Archives of Otology*, 1894, vol. xxiii., p. 24.

and thorough operations in this region, as advocated above.

The scope of this work will not admit of any detailed description of the pyæmia, for which the reader is referred to the ordinary textbooks on medicine and surgery.

Before leaving this subject, it will perhaps be as well if I recapitulate my views as to the routine of procedure in cases of mastoiditis with marked intra-cranial complications, and more or less pyæmic infection :—

1. Open and explore the mastoid cells and antrum.

2. Failing to find sufficient disease to account for all the symptoms, open the cranium in the groove of the lateral sinus, and so obtain access to both the middle and posterior fossæ.

3. Examine the lateral sinus, and search for extra- and intra-dural abscesses.

4. If a clot be found in the sinus, tie the jugular vein in the neck and clear out the sinus, &c.

5. If the sinus is not thrombosed, explore the cerebral substance above, and the cerebellar substance below the level of the horizontal groove of the lateral sinus.

CHAPTER XI.

DISEASES OF THE MIDDLE EAR—(*continued*)

NEURALGIA.

NEURALGIA affecting the auditory apparatus, and more particularly the middle ear, occasionally occurs, although not so frequently as is usually supposed.

Causes.—Dental irritation is the most common; but any of those debilitating causes that are liable to set up neuralgia in other parts of the body—ague more especially—may produce it in the ear.

Symptoms and diagnosis.—Pain of the well-known neuralgic type, usually affecting one side. This is often associated with neuralgia of the face and scalp on the same side, and is frequently aggravated by coming into a heated atmosphere, with a tendency to get worse at night or at certain times of the day, or even sometimes taking on a distinctly periodic type.

Under ordinary circumstances, it is readily diagnosed from acute inflammation by the absence of all inflammatory signs and symptoms, and by there being no lack of hearing power. A mistake is much more likely to be made in cases of rheumatoid arthritis affecting the temporo-maxillary articulation, but in these the pain is usually more persistent, and is aggravated not only on moving the jaw, but also by upward pressure at the angles. It must not be forgotten too, that certain cases of acute inflammation of the tympanum are accompanied by neuralgia, and thus the severe pain is

often continued while the inflammation is subsiding; in these mixed cases there may be much difficulty in recognising their neuralgic nature. Again, neuralgia is one of those diseases which are easily simulated, and this form of malingering is naturally very difficult to detect.

Treatment.—This should be similar to the treatment of neuralgia in other parts of the body. Exciting causes, such as carious teeth, impacted wisdom teeth, &c., should of course be removed. This may be enough to arrest the neuralgia, but as a rule in these cases, as in all those where no reflex irritation can be traced, constitutional remedies are necessary. Quinine is one of the most valuable medicines for this purpose, especially where the neuralgia is due to malaria. Indeed, when no reflex cause is evident, careful examination of the history of the patient should be made, as to whether his residence is or has been in an aguish district. At times a patient, who has some other slight middle ear affection, will complain of occasional severe pain which may readily be ascribed to recurrent inflammation, whereas it is, in fact, due to malarious ague and will readily yield to the exhibition of quinine, cinchonine or arsenic. In the case of quinine I generally prefer to give four large (5-grain) doses—after an aperient—within 36 hours, and then to continue with smaller ones. Antipyrin (gr. x.) and phenacetin (gr. v.) are also very useful, especially if the neuralgia is associated with inflammation. Where these fail, chloride of ammonium in 30 grain doses may succeed; or again, tincture of gelsemium (10-minim doses) sometimes effects a cure; or in fact any of the regular anti-neuralgic remedies may be tried. Of equal, or even greater importance than specific or local remedies, is

constitutional treatment directed towards the improvement of the general health; generous feeding, cautious stimulation, and change of air and scene, will often do much more than drugs, though iron, strychnine, and other tonics are frequently of great service.

Specific Affections.

Rheumatism and Gout.—The middle ear is undoubtedly affected by *rheumatism* and *gout*, often, as demonstrated by the late Mr. Harvey, through their action upon the joints of the ossicles. The diagnosis is sometimes difficult, but the existence of these conditions in other parts of the body, and the previous history of the patient are generally sufficient.

The treatment must be almost entirely constitutional, but in cases of acute gouty inflammation the appropriate local treatment (p. 100), as already laid down, must also be observed.

Syphilis.—*A priori* one would expect, that secondary syphilitic affections of the tympanum would be a very frequent complication in syphilitic pharyngitis; but this is not so, for they are of comparatively rare occurrence.

When it exists, the syphilitic condition must be treated constitutionally in the ordinary way, together with naso-pharyngeal injections of a mild character, such as solutions of chlorate of potash, carbonate of soda or chloride of ammonium. Applications of nitrate of silver and of perchloride of mercury, or mercurial fumigations may be useful. The Eustachian tube must be kept open by means of Politzer's bag, which is to be preferred to the catheter; for if the beak of the latter

should enter the ulcer, the cellular tissue might be inflated, producing pharyngeal emphysema (p. 48).

In some cases suppurative catarrh is set up with perforation, &c. Then the treatment for ordinary otorrhœa must be observed, and the addition of a mercurial preparation to the injections or instillations is advisable. (See Appendix). Syphilis in the tertiary stage probably interferes much more frequently with the middle ear, giving rise to the formation of adhesions, fibrous bands and other troublesome conditions, to which reference has already been made (p. 120), and the treatment of which is so unsatisfactory.

Hæmorrhagic Effusions.

In such diseases of the spleen and lymph glands as leuchæmia and Hodgkin's disease, or of the blood such as scurvy, pernicious anæmia, hæmophilia, purpura, &c., one of the most prominent symptoms is the tendency to the extravasation of blood in various parts of the body.

It occasionally happens that the ear is the seat of such an effusion. Thus, a hæmorrhage may occur between the layers of the membrana tympani, when it may be mistaken for a face-plug of cerumen, from which, however, it can be readily diagnosed by not staining a moist cotton-wool mop introduced into the meatus (p. 68). Similar effusions may likewise occur into the middle or into the internal ear.

The treatment of such cases as this must, of course, be almost entirely expectant and constitutional; occasionally the hæmorrhages may produce a certain amount of local inflammation, when the principles already laid down must be observed.

The prognosis depends entirely upon the site of the lesion and the general condition of the patient.

Carcinoma.

Primary carcinoma of the middle ear is very rare, but occasionally a carcinomatous pharynx will produce middle ear affection, from closure of the Eustachian tube. The diagnosis, treatment and prognosis scarcely come within the scope of this work.

Obesity.

Obesity by itself or as a complication, will sometimes produce middle ear deafness, from closure of the Eustachian tube by the pressure of the super-abundant fat deposited in the cellular tissue around it, as pointed out by the late Mr. Harvey. In fact the origin of the Banting treatment was due to Mr. Harvey's having diagnosed Mr. Banting's deafness as resulting from obesity, and this being removed by suitable anti-corpulent diet, the hearing power was restored.

The essence of this anti-corpulent treatment consists in abstention, more or less complete, from fat-forming foods, such as fats, starches and sugars, as well as from malt liquors, effervescing and sweet wines; all of which favour the increase of adipose tissue. The amount of tissue-forming foods should be carefully kept up, and the necessity for bodily exercise insisted upon. Lastly, the administration of saline aperients once or twice a week to relieve the portal system, is a most important part of the treatment.

CHAPTER XII.

DISEASES OF THE PERCEPTIVE APPARATUS.

THIS portion of the ear is fortunately much less liable to disease than the rest of the apparatus, for from its inaccessibility the lesions are often very obscure, and their satisfactory treatment is most difficult.

It is frequently impossible to make a differential diagnosis between affections of the auditory nerve centre, the trunk of the nerve, and the internal ear itself; by attention to the following indications, however, it is not difficult to recognise the fact, that the lesion producing the deafness is situated in one or other of these three parts of the perceptive apparatus.

1. Sounds conducted through the skull bones, are not heard so well as those transmitted through the meatus in the ordinary way (see tuning-fork tests, p. 54).
2. Notes of low pitch are usually heard better than high ones; thus the voice is heard better than the watch.
3. Extraneous sounds interfere considerably with the hearing power; thus the patient cannot hear so well in a noise, whereas it will be remembered that the reverse is the case in middle ear deafness.
4. Certain sounds are frequently associated with a sensation of jarring, which may be absolutely distressing; thus the deep notes of an organ may be quite painful to the patient.

5. Perversions of pitch are much more frequent than when the middle ear is alone affected; so that music may appear to be more or less discordant.

Any disease of the brain involving the auditory centre or tract will produce deafness more or less marked; or if the soft portio mollis is destroyed, permanent and complete deafness results. This is apt to occur in *cerebro-spinal meningitis*, from pressure due to the effusion of fluid in the sub-arachnoid space, and in certain intra-cranial lesions associated with infantile convulsions.

Some *fevers*, such as typhus or typhoid, may produce temporary deafness by involving the auditory nerve-centre; this condition must not be confounded with deafness due to the suppurative catarrh which sometimes accompanies these fevers.

Again, *cerebral tumours*, including *syphilitic gummata*, may impair or destroy the hearing power by pressure on the auditory nerve centre, or tract, or on the trunk of the portio mollis. In such cases it may be exceedingly difficult to localise the seat of the disease.

The presence of symptoms pointing to disease of adjacent nerve centres—such as interference with the sense of sight or of smell—will materially assist in the diagnosis; as also will the existence or otherwise of a syphilitic history or syphilitic lesions in other parts of the body. In these latter cases anti-syphilitic treatment should be employed; *i.e.*, large doses of iodide of potassium (10 to 30 grs.) or small doses of perchloride of mercury (liq. hydrarg. perchlor. ℥xx.), either of which it may be necessary to continue for many months.

Sometimes *fracture of the base of the skull* will produce more or less complete loss of hearing through hæmorrhage, and consequent pressure at the base of the brain.

This pressure need not be sufficient to destroy the portio mollis, and the patient may gradually recover his hearing; in these cases, therefore, an unfavourable prognosis should not be lightly given during the first few months after the accident, but should no improvement be manifest within six or nine months the outlook is very bad.

It is in cases of this nature that faradisation has been said to do good. But although I should be inclined to try it, if the hearing power did not return by the end of two or three months, yet my experience of its use has hitherto been very discouraging. In fact, no active treatment on the part of the surgeon is likely to be of service.

Congenital malformations of the auditory nerve or nerve-centre account for a very large proportion of cases of the so-called deaf and dumb. The defect in hearing may be caused by the arrest of development or by some lesion in intra-uterine life, and thus it is that congenital deafness is often associated with lack of intelligence, and that a certain proportion of idiots are quite devoid of hearing power.

The diagnosis of *deaf-mutism** from any of the above causes is a very simple matter, it being generally quite evident to any observant person, although reference is constantly made to the surgeon to decide the question. Frequently, however, in a congenital case, parents do not discover the deafness of their child until it is old enough to begin to talk; and indeed, even with the most careful parents, the defect is rarely noticed before the infant is about a year old. This often leads them

* It must be borne in mind that, occasionally, severe middle ear disease alone will result in such marked deafness that, if the patient is young, he may become a deaf-mute.

into the error of supposing that the child could hear up to a certain age, but that it had afterwards lost the power of doing so; and in these cases it is sometimes difficult to diagnose between congenital deafness and some cerebral lesion occurring during the first eighteen months.

To ascertain the existence of complete deafness, such loud sounds should be used for tests as are not accompanied by any shaking of the floor or violent movement of the air, which may be felt by the child. Thus, stamping or slamming a door form no test whatever, whereas a shrill whistle (care being taken that the air does not fall on the child), or a bell sounded behind its its back, are perhaps the best means of ascertaining whether or not the child is completely deaf. The tuning-fork applied to the skull is of but little value as a test, not only because the attention of the infant will be attracted by the contact, but also because it may feel the vibrations without hearing them.

If a sound, like that of a shrill whistle or bell, calls forth no notice from the child, that will be practically sufficient to prove that the case is one of nerve deafness (the auditory nerve in some part of its course); and should there also be an absence of any signs of middle and external ear affection, the proof may be regarded as conclusive.

It is almost superfluous to say that, in cases of complete nerve deafness, medical or surgical treatment is nearly always out of the question. The prognosis is, as a rule, most unfavourable. But occasionally in young deaf-mutes—more often where some slight amount of hearing power yet remains—we find that Nature, by gradually repairing some former mischief, sufficiently restores the parts affected to enable the patient to hear

well enough to acquire speech in the ordinary way. But this work of reparation rarely takes place unless there are signs of it before the child is five years old, and no known method of treatment will induce or hasten it; all that remains to be done is to see that the patient is taught to speak by the "pure oral" method (p. 240).

Affections of the Internal Ear.

These may be due to one of the following causes:—

1. Pressure exerted on the fluid of the labyrinth.
2. Inflammation.
3. Syphilis.
4. Mumps.
5. The effects of drugs.
6. A certain undetermined lesion producing the disease known as Ménière's disease.
7. Exposure to constant jarring noises (boiler-maker's deafness).
8. Disease of the bony capsule of the labyrinth.
9. Senile changes.

Pressure on the labyrinthine fluid may be due to several causes. Thus, a foreign body or plug of wax pressing upon the membrana tympani increases the pressure on the labyrinthine fluid, through the chain of ossicles and plate of the stapes. Under ordinary circumstances this would be compensated for by bulging of the membrane of the fenestra rotunda; but when this is prevented by chronic thickening, &c., or when the pressure is more than sufficient to be counterbalanced by the bulging, then the internal ear may become affected. Thus, in cases of long-standing tym-

panic catarrh where the perceptive apparatus has become defective, I think that probably this is due to the pressure of the stapes not being compensated for by the bulging of the fenestra rotunda, owing to its having become thickened by the catarrh.

In some cases of chronic catarrh of the tympanic cavity alteration of the pitch is noticed, so that the same tuning fork applied successively to the two ears appears to strike a higher note in the one than in the other. This is due, I believe, to the altered tension of the labyrinthine fluid from pressure of the stapes as already described.

Besides producing disturbances of the hearing portion of the internal ear, the pressure sometimes affects the posterior labyrinth, and then vertigo may result. Thus, the mere act of syringing, especially when there is a large perforation of the membrana tympani, will frequently produce giddiness, sometimes with distinct rotatory sensations. Now and again a plug of wax or foreign body may occasion all these symptoms, and the patient might at first be supposed to be suffering from Ménière's disease proper, but on removal of the obstacle these troubles will disappear.

Inflammation.—Inflammation confined to the internal ear is very rare, but it sometimes occurs without any inflammation at all in the tympanic cavity. In such cases we have deep-seated pain, usually very severe; but all signs of tympanic affection are absent.

Giddiness, staggering, nausea and vomiting, and marked tinnitus are present. The deafness, as a rule, is complete on that side, and the tuning fork test shows that the skull-hearing is diminished instead of being exaggerated as in tympanic affections. Another occasional, though very rare condition, is that to which the

term "sonophobia" may be applied. In these cases, in addition to the symptoms of slight inflammation of the internal ear, there is a most distressing dread of noises. Whatever the true cause, the treatment indicated appears to be that which is applicable in cases of acute and sub-acute inflammation of the internal ear, *i.e.*, brisk counter-irritation, as by drilling the outer table of the mastoid process. A typical case occurred in a boy of 14 under my care. The sonophobia appeared about two months after I had opened a superficial mastoid abscess by Wilde's incision, and was completely cured by drilling just into the mastoid process.

In the course of suppurative catarrh of the tympanum, whether acute or chronic, the inflammatory condition will sometimes extend to the internal ear.

Occasionally, where there is severe or prolonged tympanic inflammation, as in scarlet fever, there may be loss of the stapes, which necessarily results in total destruction of the internal ear, and this is probably the most frequent cause of the complete deafness sometimes met with after scarlet fever. Such cases are of course rare, but it is not at all uncommon for acute inflammation to extend from the middle to the internal ear, thus producing more marked deafness, considerable tinnitus, vertigo with rotatory sensations, nausea and vomiting. The vomiting is frequently a very marked symptom, and will sometimes continue for twenty-four hours or more, leading the physician to fear cerebral complication. But the long continuance of this vomiting, and the presence of vertigo and tinnitus, together with the signs of middle ear mischief, and the absence of other symptoms of meningitis or intra-cranial trouble, are usually sufficient to enable a correct diagnosis to be made.

Complete rest, with blisters behind the ear, two or three leeches in front, together with a smart purgative, form the chief methods of treatment upon which I rely. I frequently, too, give large doses (40 min. to 1 drm.) of hydrobromic acid to quiet the nerve irritation.

Prognosis.—In inflammation of the internal ear the prognosis must be very guarded. As a rule, some amount of permanent loss of hearing will result; while in many cases the deafness is absolute and permanent, and then no future treatment is likely to be of any avail.

Syphilis.—Occasionally, *acquired syphilis* in the tertiary form will attack the internal ear, and then we get symptoms somewhat akin to those of simple inflammation, except that the pain is less marked, duller in character and apt to be worse at night. This, together with a syphilitic history, and possibly the presence of the disease in some other part of the body, will enable the physician to make a correct diagnosis.

Its treatment does not differ from tertiary syphilis in any other part of the body. I prefer large doses of iodide of potassium (5 to 10 grs. or sometimes even more) three times a day. If the pain is excessive a blister may be used with advantage, while if it becomes very chronic, minute doses of mercury (perchloride) continued for several months, will generally be found beneficial.

Congenital syphilis accounts for a much larger proportion of cases of internal ear disease than does acquired syphilis. The affection is more common in females than in males, usually occurring between puberty and the age of twenty, though occasionally earlier or later in life; and is almost invariably preceded by interstitial keratitis. This condition of the cornea generally

lingers on for some months, and then, as it passes off, the ears (one or both) become gradually affected, or as the patient often characteristically describes it, "I got gradually deafer as my eyesight returned." Although as a rule deafness is the only symptom complained of, yet occasionally there is also some vertigo. Sometimes the deafness steadily increases until it has become complete, but more frequently the disease is arrested or passes off before producing total loss of hearing power.

Pathologically, these symptoms are the result of chronic ostitis, which leads to the gradual and more or less complete occlusion of the cavities of the internal auditory meatus and bony labyrinth, with the consequent injury to, or destruction of, the delicate soft structures contained in these situations.

The diagnosis is usually very easy. The keratitis or the opacity left behind, together with the lingering nature of the case, the deafness coming on as the eyesight improves, the diminution in the skull hearing as tested by the tuning-fork, and the existence of Hutchinson's "pegged teeth," will all help to form an accurate diagnosis. Occasionally, a careful search has to be made before the slight opacities of the cornea are discovered; or again, the teeth may not be very characteristic, especially when they have been worn down; in some rare instances, the ear affection precedes the keratitis, when the diagnosis will be more difficult. The case, too, may be complicated with some disease of the middle ear.

In a confirmed case no treatment is of any avail. This is the verdict of Hutchinson, confirmed by the experience of every aural surgeon. But in the early stage, when the symptoms are developing, I have found that repeated blistering behind the ear has sometimes

produced very marked improvement, and would strongly urge that this treatment be persisted in for several months in all such cases. As suggested by Politzer, hypodermic injections of pilocarpine may be tried. For this purpose 3 to 6 min. of the one per cent. solution of the hydrochlorate should be injected once a day for a fortnight; if any improvement is manifest the injections may be continued for a month, but if no satisfactory result is obtained they should be dropped. At the same time every attention should be paid to the general health. I do not think the exhibition of mercury is of any use.

Mumps.—At times, although the occurrence is comparatively rare, the internal ear is destroyed during an attack of mumps; but when this is the case only one ear is, as a rule, affected. This condition rarely comes under the notice of the aural surgeon until long after the mischief has been done, and when the time for any successful treatment is past. But if the case could be seen at the onset of the deafness I believe it would be possible to save the hearing, in a certain proportion of cases, by energetic blistering behind the ear.

It must not be forgotten that mumps may produce deafness by interfering with the middle ear, but any difficulty of diagnosis between this and internal ear mischief may be easily cleared up by means of the tuning-fork test.

The effects of drugs.—Certain drugs, but especially quinine and salicine, appear to have a direct influence on the internal ear, large doses of these producing tinnitus and deafness. These results, however, almost invariably pass off after a time, although in some few cases, the prolonged use of large doses has been followed by a considerable amount of permanent deafness. The

mode in which they act is not really known, but arguing by analogy from the effect of quinine on the retina, it is generally presumed that the drug produces anæmia of the labyrinth, in the same way as it certainly does anæmia of the retina. But whereas the effect upon the ear is almost always of a transitory character, that on the eye, as we are informed by eminent ophthalmic authorities, is more permanent.

This action of large doses of quinine has led some aural surgeons to be very chary in the use of this drug, even as a tonic in small quantities. This, I think, is a mistake.

Ménière's disease or **labyrinthine vertigo.**—The late Dr. Ménière of Paris was the first to distinguish this affection of the posterior labyrinth (semi-circular canals and utricle), and his observations have been more or less corroborated by many later authorities both in pathology and physiology.

It is now generally recognised that the train of symptoms known as Ménière's disease is due to some lesion in the posterior labyrinth. But as there is some confusion with regard to what is meant by Ménière's disease, I prefer drawing a distinction between Ménière's symptoms or symptoms of irritation of the semi-circular canals, produced by some external influence such as pressure or extending inflammation, and Ménière's disease proper; the latter is probably due to a lesion in the labyrinth itself, and appears to run a more or less definite course.

Ménière's symptoms.—These have already been alluded to from time to time as a complication of other diseases.

They consist, when fully developed, of marked tinnitus, usually of an accentuated character; severe vertigo

with rotatory sensations and consequent staggering movements on the part of the patient; nausea and vomiting; sometimes a sense of faintness and great depression.

The rotatory sensations will depend for their direction upon which of the semi-circular canals is affected. Thus, pictures on the wall may appear to move from right to left, or from left to right, or round and round in the direction of the hands of a clock; or the floor may seem to rise upwards or fall downwards, from side to side, or from before backwards; so that the patient may tend to fall to the right or to the left, to pitch forwards or to fall backwards. Sometimes the patient has a sense of lightness, or he may describe a fancied feeling of looking over the top of a house. Again, a very common symptom is that of appearing to sink backward into space. All these sensations are aggravated by turning the head, more especially when it is turned in such a direction, that the axis of the affected semi-circular canal is in the same plane as the axis round which the head is moving. That is to say, it sometimes happens that while no giddiness is produced by movement from right to left of the head in the ordinary position, yet if it is thrown backwards and the body moved from right to left, vertigo is the result. As a rule the affected side is that towards which the patient tends to fall.

The vertigo and rotatory sensations are sometimes sufficiently sudden and severe to make the patient really fall, but usually they are not so great as this, and in the milder forms he will simply describe the act of walking as if he were on board a ship at sea. Indeed, I may here call attention to the marked similarity that exists between Ménière's symptoms and sea-sickness; otolo-

gists generally consider the latter to be chiefly the result of semi-circular canal disturbance.

Nausea and vomiting are usually present in this disease, and sometimes the vomiting is very presistent.

When Ménière's symptoms occur as a complication of some other condition, the treatment must be directed chiefly to the cause, as with its removal the resulting vertigo will also disappear. For example, when a plug of cerumen pressing upon the membrana tympani produces vertigo, the removal of the plug will arrest it. In the same way, when inflammation of the tympanum extends into the internal ear producing vertigo and vomiting, all that is usually necessary is to treat the inflammation (p. 103). Occasionally, however, the semi-circular canal irritation continues after the exciting cause has passed away; when this is so it must be treated as a case of Ménière's disease now to be described.

Ménière's disease proper appears to me to be a definite disease, as originally stated by Dr. Ménière. It is met with in two forms, which, from the mode of seizure, may conveniently be termed:—(1) the epileptiform; (2) the apoplectiform; but it is not at all intended that these names should imply a cerebral origin for the lesion. Very probably the epileptiform seizure is caused by recurrent congestions or irritations of the posterior labyrinth, whereas the apoplectiform attack is the result of a single severe hæmorrhage or exudation into the whole labyrinth, sufficient to destroy its functions (hearing and equilibration) at once and for ever.

Although we are rarely able to assign a cause for this condition, a low state of health is undoubtedly a predisposing cause, as we meet with patients who may

have had one or two of these attacks in a long period of years, and each time it has occurred just when they were in a debilitated condition. Again, I believe I have traced it to a gouty origin in some cases, and in others to sun-stroke; but as already stated, in by far the majority of cases no sufficient reason for it can be discovered.

Course and symptoms.—The epileptiform disease is characterised by attacks of Ménière's symptoms, already described, coming on at regular or irregular intervals, something like epileptic attacks. In the intervals the patient usually feels quite well, although there may be some tendency to vertigo. A typical seizure commences with a sudden tinnitus of an accentuated character, soon followed by vertigo and rotatory sensations, and later on by nausea and actual vomiting.

These attacks on passing off, leave the patient feeling quite well, unless the vomiting has been excessive. They may be mild or severe, lasting from a few minutes to several hours, recurring once in two or three months, or as often as two or three times a day.

In the earlier stages there is often no deafness, but as the disease advances the patient notices that he is somewhat deaf during the attack, and later still there is a certain amount of permanent deafness, which the tuning fork shows to be due to internal ear affection. Eventually, if the disease runs its full course, the hearing is entirely lost, the attacks become less frequent and less marked until they finally disappear altogether, or only leave behind a tendency to occasional slight vertigo, and, almost invariably, marked tinnitus. As the disease is passing off, the seizures are apt to be very sudden in onset and almost momentary in duration, and, therefore, it is in this stage that serious accidents

from falls are particularly likely to occur. The disease, as a rule, takes two or three years to run its course, but it may be arrested at any period, and then the hearing usually remains *in statu quo*, although sometimes it actually improves. In the apoplectic form the patient has only one severe, and it may be prolonged attack, followed by complete and permanent deafness on the side affected. For a few days after the attack there is frequently slight vertigo, often accompanied by marked hyperæsthesia of the auditory nerve; and, lastly, distressing tinnitus nearly always persists. Fortunately, it is very rare for the disease to affect both ears, but should this occur, absolute deafness may of course result.

Diagnosis.—Ménière's disease is frequently mistaken for epilepsy, cerebral disease, or for what is commonly known as biliousness. In fact, it is of much more frequent occurrence than is usually supposed, although, if the case be carefully examined, its diagnosis is by no means difficult. Not infrequently a patient consults the aural surgeon for unilateral deafness of considerable duration, stating that there is no known cause for the trouble; but on enquiry it can often be traced to an attack of vertigo, which neither the patient nor the medical attendant ever suspected to be of aural origin.

It is *distinguished from epilepsy*:—

1. By the absence of convulsions; the existence of which would alone show that the case was not simply one of Ménière's disease.

2. By the absence of drowsiness after the attack. The weariness produced by the prolonged vomiting must not be confounded with the drowsiness that comes on after an epileptic fit.

3. By there being no loss of consciousness. Should there be decided loss of consciousness, this would be

conclusive evidence against its being uncomplicated Ménière's disease.

Attention to these three points are generally sufficient to enable the surgeon to arrive at a correct diagnosis. For further guidance, we have the peculiar tinnitus so very characteristic of this disease; the rotatory sensations; the nausea and vomiting; the irregularity, both in the duration and the recurrence of the attacks; the possible presence of some vertigo betweenwhiles; and in most cases, the internal ear deafness.

The only times when there is any real difficulty in diagnosis, are in some slight attacks of Ménière's disease, which may be confused with the "*petit mal*" of epilepsy.

To distinguish from brain disease.—This may be very difficult when the nerve-centres of equilibration in the cerebellum are affected, because in this form of brain disease all the Ménière's symptoms are at times present. But, as a rule, when it is the result of a cerebellar lesion, the symptoms are more marked and persistent. Again, if due to brain disturbance, other nerve-centres are almost invariably affected and thus give rise to further symptoms.

To distinguish from bilious attacks.—Although nothing is more common than confusion of these two, yet Ménière's disease may be easily diagnosed from biliousness by absence of headache; by freedom from malaise, both immediately before and after the attack; by the severity of the vertigo; by the rotatory sensations, the peculiar tinnitus, and by the deafness if present.

Between the attacks the diagnosis may be assisted by trying the effect of sudden rotation. Thus, if the physician twists the patient's head sharply in the axis of the semi-circular canal affected, vertigo will result.

Treatment.—Epileptiform Ménière's disease will often yield to appropriate treatment.

In very chronic cases large doses of quinine will sometimes yield very good results (Charcot); but personally, I have found far more benefit derived from the use of bromine in some form, and from salicylate of soda. Roughly speaking 70 or 80 per cent. of these cases are more or less completely arrested by bromine, either in the form of a bromide, or, better still, of hydrobromic acid. But occasionally salicine, or salicylate of soda, will arrest the disease when bromine has failed. At times the effect of the bromide or hydrobromic acid is instantaneous; as, for instance, in the case of one of my patients, an otherwise healthy young man, in whom the vertigo was brought on by the least movement of the head. After a single dose of bromide of potassium he was able to turn his head without giddiness, and a continuance of it for six weeks completely arrested the disease.

In the apoplectic form, the case is rarely seen before all the damage is done, but should it be seen early a blister behind the ear ought to be tried. After the attack, quiet and bromides for the hyperæsthesia are indicated.

I prefer the hydrobromic acid as being far less liable to depress, both mentally and bodily. I usually give from 30 minims to 1 drm. of acid. hydrobrom. dil. (B.P.) three times a day; sometimes even as much as 1½ drm., the small doses ordinarily advised not being sufficient. If salicylate of soda is used, 10 to 15 grs. three times a day should be given.

These medicines may be combined with tonics when their use, as often happens, is indicated. As already noticed, debility decidedly predisposes to these attacks,

the general health, therefore, should be carefully maintained in every possible way. Should a gouty diathesis be present, suitable treatment must be adopted and a strictly anti-gouty regimen enforced. Some authorities, arguing from the supposed analogy of cerebral apoplexy, adopt antiphlogistic treatment, but it is obvious that a minute hæmorrhage into such a confined space as the labyrinth cannot be viewed in this light, and, moreover, such treatment would be too late to be of any service.

Prognosis.—If allowed to run its course the epileptiform disease, as already stated, tends to wear itself out after the functions of hearing and probably of equilibration have been destroyed, and then no manner of treatment is of any use. But if the disease is taken early, it may generally be arrested, if not cured by treatment; the hearing, if affected, remaining *in statu quo*, or, in some rare cases, actually improving. There is, however, considerable tendency to relapse, even after many years, should the patient become debilitated from any cause whatever. In apoplectiform cases the damage is at once complete, and no improvement in the hearing can be expected.

Boiler maker's deafness.—It has long been known that boiler makers, who are subjected to the constant din of hammering inside boilers, are very liable to become deaf, and many explanations of the pathology of this affection have been given.

Politzer has suggested that the recurrent loud vibrations may produce some loosening of the joints of the ossicles, and thus the chain, as a conductor, is impaired. But though this explanation may be correct to a certain extent, yet undoubtedly it cannot be accepted as the chief cause of the deafness. For it has been pointed

out by Roosa and confirmed by aural surgeons practising in the ironwork districts, that the defect is chiefly in the internal ear, as shown by the tuning-fork and other tests. I have myself been able to confirm this, having carefully examined a number of such cases, in all of which I found that the internal ear was the chief seat of the mischief; although, except in early stages of the disease, the middle ear was also involved.

The following three cases will serve as illustrations:—

D. K——, age 50. Has been working in boiler maker's shop 30 years. Began to get deaf 5 years after he commenced work. No increase of deafness for the last 10 years. Hears ordinary distinct conversation at several yards; a 50-inch watch not heard on either side, even on pressure against the ear. Tuning-fork on bridge of nose heard 0″ (the normal length of time). These results point distinctly to the existence of both internal and middle ear affection; the effect of the one being exactly counterbalanced by the effect of the other, so far as the tuning-fork is concerned (p. 57). No doubt the middle ear affection in this case was partially catarrhal, for after Politzerisation the tuning-fork was heard $\frac{1}{4}$″ minus.

W. P——, age 57. At the works 37 years. Deafness began 25 years after commencing work. Gradually becoming worse. Hears direct conversation at several yards; hears the watch on touch by left ear, but not even on pressure on right side. Tuning-fork 3″ minus. After Politzerisation 5″ minus. This is a more typical case, and one in which the middle ears were only slightly affected.

H. F——, age 17. At work 2 years. Getting deaf ever since commencement. Hears distinct conversation at many yards. Watch, left side $\frac{2}{60}$; right side

complicated by perforation and otorrhœa. Tuning-fork on nose o". Here again, the internal ear affection compensated, so far as the tuning-fork was concerned, for the effect of the middle ear mischief. In this case there were also signs of chronic middle ear catarrh.

These three cases demonstrate, I think, that the internal ear is the chief seat of the mischief, and no doubt this defect is due to the constant jarring. Mr. Hewetson of Leeds very aptly likens it to the effect of prolonged exposure of the eye to direct sunlight. In each case the nerve is partially paralysed, and on continuance of the cause, permanent impairment is the result.

As regards treatment, nothing but complete change of occupation appears to be of any use. Frequently, when the patient is entirely removed from the source of the mischief, the hearing power gradually improves.

Disease of the bony capsule of the labyrinth.—Politzer has recently shown* that in some cases, usually classed under the head of middle ear sclerosis, the progressive deafness is due to a primary disease of the capsule of dense bone which surrounds the internal ear. Irregular shaped bony nodules appear in this capsule, and at an early stage the fenestrum ovalis is invaded and the stapes becomes fixed; gradually the labyrinth is encroached upon, and the functions of the internal ear completely destroyed. It is usually a disease of advanced life, but may attack younger people; it shows a marked hereditary tendency.

In the present state of our knowledge the diagnosis is somewhat difficult. The symptoms most to be depended upon are the progressive deafness, slowly be-

* "Primary Disease of the Bony and Labyrinthine Capsule." *Archives of Otology*, 1894, vol. xxii., p. 255.

coming absolute or nearly so; marked and persistent tinnitus, which occasionally disappears as the deafness becomes complete; very defective bone conduction; absence of any signs of middle ear catarrh; and occasionally, redness and irregularity of the promontory as seen through the membrana. The prognosis is very bad, and treatment of little or no avail; Politzer suggests a trial of the iodides in the earlier stages of the disease.

Senile changes.—As old age approaches the hearing power tends to diminish, this tendency being much greater in some persons than in others, and it does not necessarily follow in the same proportion as the degeneration in other parts. Thus the aural surgeon is frequently consulted for deafness by very old people who are much more vigorous than their years would imply, being, physiologically speaking, younger than their age.

These senile changes are partly tympanic as already noticed (p. 121), but they are also partly labyrinthine and nervous (auditory nerve and nerve centre).

The diagnosis, which is important on account of the definite though unfavourable prognosis that may be given, is comparatively easy. Besides the deafness and other signs of middle ear trouble, we find that the patient hears worse in a noise, and that the skull conducting power, as shown by the tuning-fork, is either about normal or actually diminished. Under ordinary circumstances, of course, the middle ear mischief should give rise to increase in the skull conducting power, but in these senile changes this increase is more than counteracted by defects in the internal ear or nerve.

As already stated, the prognosis is most unfavourable; treatment is of little or no avail, and gradual increase in the deafness is to be expected.

CHAPTER XIII.

EDUCATION OF SO-CALLED DEAF-MUTES—ARTIFICIAL AIDS TO HEARING.

Education of Deaf-Mutes.

It must be distinctly understood that the defects of the auditory apparatus have no influence, except indirectly, upon the organs of speech. Although it is true that a person who has not had sufficient practice in the art of speech before becoming deaf, may lose that art completely—as indeed is usually the case when deafness has come on before the age of seven years, or even somewhat later—yet we must remember that this condition is not the result of organic change, but simply a natural consequence of the person's inability to imitate the voice of others, and to appreciate the results of his own efforts of articulation. With little children this inability no doubt forms an almost insurmountable obstacle to their acquirement of speech, for imitation is to them the best mode of tuition, and their difficulty in producing sounds they cannot hear is extreme.

Until within the last ten or fifteen years most people in England, the United States and our Colonies, considered it practically impossible to teach speech to the deaf, and hence these were described as deaf-mutes or deaf and dumb, a term not, however, scientifically correct. That this view was erroneous is shown by the fact that instances did occur, both in England and in other countries, as far back as the middle of the 7th

century, where the "deaf and dumb" were taught to speak. Gradually, this possibility became more and more acknowledged, and methods of instruction were organised and developed, more especially in Germany, where between 1760-1778 it became the National System. The practice has, since then, spread all over the Continent, with perhaps the exception of Belgium, but even there it now seems to be making way.

This, the German, or pure oral system, so-called in contra-distinction to the French or sign system, demands great skill, patience and method on the part of the teacher, and earnest perseverance on that of the pupil; but the extreme value of the art when acquired, breaking down, as it does, the blank wall of separation between the heretofore deaf-mute and his fellow-men, more than repays the many years of patient labour.

It does not come within the scope of this work to describe the methods employed in the German system, but I may say that it consists mainly in training the pupils to produce, first the simpler, and gradually the more complex articulate sounds, by watching the motion of the teacher's lips and tongue. When all the sounds necessary to the language have been mastered they are formed into words, and the meanings of these words taught by objects, models, pictures, actions, &c., until at length the child is able to express his ideas by speech, and to understand what other people say by following the movements of their lips; for this reason the method is sometimes styled the "lip-reading system." Although the systematization of this method is of comparatively modern origin, yet it must be noted that a large number of intelligent people who have had the misfortune to become deaf, instinctively adopt this plan of their own accord without undergoing any formal training. And

further it may be remarked, that acuteness of vision, or even some degree of hypermetropia is of great advantage in all such cases.

This speech education is carried on concurrently with the general education of the child. All use of signs is forbidden, as otherwise the pupil, preferring the easier method, will not be likely to exercise that patience and perseverance that are absolutely necessary to enable him to overcome the difficulties of the German system. I am told that a child may begin to be taught between the ages of 5 and 6, but where only a limited number of years for school education is possible, it would be wiser to commence a couple of years later. In cases of congenital or infantile deafness, seven or eight years should be devoted to the training; but when deafness has come on after the child has learnt to speak, a much shorter time will suffice, as he will only require to be initiated in the mysteries of lip-reading.

Modulation of the voice cannot be acquired, it is true, and hence the speech of educated deaf persons is necessarily inferior to that of ordinary individuals; but, nevertheless, the amount of success achieved by this method is most remarkable, pupils well trained being enabled to converse quite readily, and in a manner to be well understood. They are no longer shut out from intercourse with the world around them, and this incalculable blessing can hardly be over-rated.

When the surgeon is applied to for advice as to which method is to be adopted in any individual case, the following suggestions may serve to guide him in the formation of his opinion.

1. In all cases where deafness has come on after speech has been acquired, lip-reading should be taught, unless the patient is either too old or too much con-

firmed in the use of signs. For I may here remark, that teachers of the German system appear to be agreed, that its difficulties can rarely be overcome by adults who, having already been deaf for years, are thoroughly confirmed in the habit of using signs. With children and young adults who have only recently lost their hearing the study of lip-reading is strongly to be recommended, and it is also well to insist upon the necessity of the patient reading aloud for one or two hours daily, to prevent the art of speech being lost.

2. Persons who are born deaf, or who have lost their hearing so early that they have never learnt to speak, may be divided into two classes—those who possess ordinary intelligence, and those who are more or less deficient in intellect. For the former the use of the German system should undoubtedly be urged, but for the latter no such rigid rule can be laid down. Unfortunately, congenital deafness is frequently accompanied by more or less intellectual deficiency, and when such is the case the French sign system may be preferable, because it is more easily acquired, especially when the lack of intelligence is so great that it amounts to idiocy.

The necessity for legislation upon this subject has at length been recognised, and Acts of Parliament have now been passed by which the School Boards are bound, not only to undertake the education of deaf-mutes, but also to provide for the boarding out of the children, when the institutions at which they are being instructed are situated at some distance from their homes. On the other hand, except in the case of those under 7 years of age, this infirmity cannot now be put forward by the parents as a "reasonable excuse" for non-attendance at school.

Aids to Hearing.

The surgeon is frequently required to give an opinion upon the relative advantages to be derived from the various forms of ear trumpets, &c., in individual cases, and it is therefore important to consider the *modus operandi* of these instruments, so as to ascertain whether, in the case before him, any real help can be given through their agency. This is the more necessary as there is so much deception practised among what I may call "quack vendors," who are ready to foist on their unfortunate customers all kinds of useless and sometimes even harmful appliances, with the assurance that they will materially assist the hearing power.

First of all, I need hardly say, no help can possibly be given when the function of the internal ear or nerve centre is completely destroyed. And even when this is only partially impaired, no practical aid to hearing will be given by audiphones, ear trumpets, tubes, &c., while at times they actually produce injurious results.

When the deafness is due to affection of the conducting parts, then ear trumpets, cornets, conversation tubes, &c., decidedly increase the hearing power, for they help to collect the sound-waves and conduct them more directly to the membrana tympani than would otherwise be the case. And also in mixed cases of deafness, viz., of the conducting and perceptive portions, these aids may be of service.

In cases of extreme deafness from affection of the conducting powers alone, that is to say, when there is *no* affection of the auditory nerve, the audiphone and its allied instruments are of use. Unfortunately, there is

such a very minute proportion of cases of this kind, that only an extremely small percentage of deaf patients can be benefited by these instruments, which seemed to promise so well when first brought out.

Trumpets.—As a rule, very small trumpets are useless. The best forms are the various bell shapes, and the conical funnel; but it is well for the patient to try many differently shaped ones, so as to find which is the most suitable and convenient to him individually.

Occasionally their use is accompanied by a murmur similar to that heard in a shell; this may be stopped by putting a little very lightly pulled-out wool inside the trumpet. Sometimes the ear piece introduced into the meatus will cause irritation; in such cases the end should be flattened like that of a stethoscope, and used in the same way, *i.e.*, by simple pressure on the auricle.

Ear cornets consist of a pair of small ear trumpets, one for each ear, held in position by a simple spring passing over the head from ear to ear. These are sometimes very useful, and of course require no holding, but care must be taken not to have them too small.

Politzer has introduced a small horn-shaped meatus cornet, which is so worn that its opening is turned backwards towards the cavity of the concha; by which means, he assures us, the hearing power is doubled in a large proportion of cases.

Meatus tubes.—Simple meatus tubes, such as are used for opening a collapsed meatus (p. 65), are absolutely useless as ear trumpets, although they are constantly being sold as such by unscrupulous vendors; the deaf person being tempted by the fact that they are almost invisible.

Conversation tubes.—With very deaf patients a conversation tube will be of greater service than any

other form of trumpet. It consists of a conveniently long tube with a dilated mouth-piece at one end, and the ordinary nozzle fitting the meatus at the other. By means of this the patient is able to converse much more readily with one person, but if he wishes to enter into general conversation the ear trumpet is more useful, as he can shift that about in whichever direction he desires. Speakers should be particularly warned not to shout or blow either into the trumpet or conversation tube, but should be instructed to speak *across* the opening of the latter, and not to put their mouth very close to the former.

When the patient is suffering from hyperæsthesia of the acoustic nerve, the use of either trumpet or tube is distressing, and should be avoided.

Audiphones.—Some years ago Mr. Rhodes, of the United States, brought out an audiphone, which consisted of a fan-shaped plate of vulcanite, rendered tense by bending. The teeth being applied to the upper edge, the sound-waves which strike upon the plate are picked up and carried, through teeth and skull-bones, to the internal ear itself, the audiphone thus being utilised as a veritable artificial tympanum.

A few months before Mr. Rhodes published an account of this instrument, I had succeeded in making a somewhat similar one. Mine consisted essentially of the vibrating tympanum, similar to that of the phonograph, with a long style that did duty for the chain of ossicles or columella, the end of which was to be applied to the teeth. I was at first greatly delighted with the result of this contrivance, for a deaf patient who tried it, found that it enabled him to hear conversation quite easily. But I soon discarded any idea of suggesting it for general use, as it was only in the case of this one

patient that I found my audiphone to be helpful, while in almost all others greater assistance was given by the ear trumpet.

On testing Rhodes' instrument, which is far more convenient, I found that it acted equally as well as, but no better than, mine. Later on, Professor Colladon of Geneva, suggested the use of a piece of stiff cardboard applied like Rhodes' audiphone, and this I have found to be preferable to both the others. Unfortunately Rhodes has patented his instrument, and therefore the cardboard one cannot be sold.

It is a great pity that the audiphone cannot be so perfected as to make it of general use in all cases of middle ear deafness; for it may fitly be regarded as a great triumph from a scientific point of view, as by it we are enabled to pass articulate sounds direct to the internal ear, thereby replacing, when necessary, a defective conducting apparatus. But as it now stands, the audiphone is only of real use in about one in every thousand cases of marked middle ear deafness.

Dentiphone.—This is a form of audiphone, circular in shape, in which the centre of the vibrating disc is attached to the teeth by means of a string. It is of less value than the preceding.

A conducting rod passing from teeth to teeth, or from the larynx to the teeth, has been suggested, but although this does conduct the voice, it is of no real practical value.

Ear drums.—In conclusion I think it only my duty to issue a word of warning against the indiscriminate and unadvised use of so-called "ear drums" as artificial aids to hearing. They can only be of service in certain cases of perforation, and even then the simpler forms of artificial tympana described (p. 163) are always to be

preferred to the rough and more or less complicated instruments, which have of late been so much vaunted and pushed. If used in other cases than those alluded to, not only will they serve no useful purpose, but they may do a very great deal of harm.

CHAPTER XIV.

HEARING BETTER IN A NOISE—TINNITUS AURIUM—EAR COUGH.

In this chapter I propose to discuss certain peculiar symptoms which could not conveniently be considered in their physiological order.

Hearing Better in a Noise, or Paracusis Willisiana.*

As already noticed while discussing advanced middle ear disease, certain patients undoubtedly hear better in a noise. That is to say, such patients will hear conversation far more easily either when church bells are ringing, or when riding in an omnibus, train, or other ratling vehicle, than they would in a quiet room. And though this, no doubt, is partly due to the speaker naturally raising his voice under such circumstances, yet it has been proved by Politzer and Roosa that there is, besides, an actual improvement in the hearing power.

In all probability the chief reason of this improvement is, that these loud noises do not interfere with a deaf person so much as with an ordinary individual. I believe that to a great extent loud noises prevent a normal

* This was first described by Dr. Thomas Willis, *Opera omnia*, Amstelædamia, apud Henricum Wetstenium. Pars Physiol., Cap. xiv., p. 69.

individual from hearing because they cause a jar upon the internal ear; and, therefore, if a person's middle ear is defective, the vibrations being conducted less perfectly the jarring effect is not so great. The following little experiment will bear out this suggestion. If anyone with normal hearing, when travelling in a rattling vehicle will lightly close his ears with his fingers (thus, as it were, simulating a defective middle ear as regards its conducting power), he will lose much of the jarring noise, and be enabled to hear quite as plainly as when his ears are unstopped. The louder the jarring noise the more marked this phenomenon will appear, and if for instance we make the experiment in a boiler-maker's shop, the result is most striking, conversation being heard far more pleasantly and with much greater distinctness than when the ears are unstopped. Professor Roosa, of New York, at the Otological Congress (Basle, 1884), said that he was convinced that *all* persons suffering from middle ear deafness hear better in a noise. Now if my explanation be correct this statement will only apply to cases of severe middle ear deafness; that is to say, where the middle ear affection is sufficiently marked as to preclude the jarring effect of loud sounds from passing through to the internal ear. And this theory is further borne out by the fact that persons afflicted with *internal ear deafness* do not experience this improvement under similar conditions; on the contrary, even moderate noises interfere with their hearing power, as already noted by Professor Roosa. But these theories only partially account for the phenomenon, which we do not even yet thoroughly understand. For further information on this interesting subject the reader is referred to Roosa's *Diseases of the Ear*, sixth edition, pp. 22, 355.

Tinnitus Aurium.

Noises in the ear are, of course, merely a symptom of disease due to some disturbance of the function of hearing, as already noted in the introduction. It might, therefore, seem to be as much out of place to treat tinnitus aurium by itself, as to speak separately of the symptom of deafness; but for many reasons I think it will be practically useful to say something concerning it as a whole.

Various authors have divided noises in the ear in many ways, none of which seem to me to be quite satisfactory. Indeed, I do not think it possible to separate the different kinds by any sharp line of demarcation, though for purposes of description they may be roughly grouped together according to the following characteristics:—

1. Clicking (from muscular spasm).
2. Pulsating (synchronous with the pulse).
3. Rushing, blowing, and hissing noises.
4. Musical.
5. Voices.

Clicking tinnitus is an objective form of noise, and can be heard by the observer as well as by the patient; in fact sometimes, when very loud, it may be detected at a distance, although at other times it can only be distinguished by the surgeon by means of the diagnostic tube. The clicking noise may perhaps be more fitly described as being like the sound produced by the winding up of a watch. In some cases it can be voluntarily produced, but as a rule it is not under the patient's control. This is one of the rarest forms of tinnitus, although most aural surgeons have met with cases

of it now and again. It has been fully described by Dr. Burnett and others; and Dr. Fitzgerald, of Dublin, read an interesting paper on the subject at the International Medical Congress, London, 1881 (p. 44, *Trans.*).

The clicking noise is distinctly not synchronous with the heart, and is apt to cease altogether for a time, and then come on again without any apparent reason. It is due to spasmodic contraction of one or more of the muscles of the palate, and this, acting on the pharyngeal opening of the Eustachian tube, causes a valve-like opening and shutting, and so produces the noise. There must also be some catarrh present rendering the surfaces of a somewhat sticky nature.

This form of tinnitus has been ascribed to spasmodic action of the tensor tympani and stapedius muscles; but though it is possible that spasm of these muscles may produce some form of tinnitus, the one in question is undoubtedly due to palatal spasm, as just stated. I have noticed that spasm of the orbicularis oculis, and other facial muscles, is sometimes associated with this affection.

The treatment should be directed first to the catarrhal condition, which as a rule soon yields sufficiently to arrest the tinnitus; and secondly, to the spasmodic affection itself. This must be treated by nervine tonics, cold douches, and other bracing regimen, as the case may indicate.

Pulsating tinnitus, strictly speaking, must in all its varied forms be considered objective, although it is only audible to the surgeon in a very few cases.

Occasionally, this pulsating tinnitus is an accompaniment of a cardiac bruit; or again, the bruit of an aneurism in the neighbourhood of the ear may be the source; while sometimes, as in chlorosis, a venous mur-

mur will be heard by the patient. The noise may be audible to the surgeon by means of the stethoscope in such cases, but these are the rarer instances of pulsating tinnitus. More frequently, this peculiar throbbing (synchronous with the pulse) is met with in congestion of the middle or the internal ear. The treatment of this tinnitus must be the treatment of the condition producing it. But there is a form of pulsating tinnitus—due probably to some vascular disturbance of the middle or internal ear—which is said to be considerably modified, if not cured, by the use of hydrobromic acid (Woakes); although I must own that, as a rule, where I have tried it even in large doses, it has failed to yield satisfactory results.

In connection with this part of our subject we may note the effect of certain drugs, which are apt to produce tinnitus, probably through the medium of the circulation in the internal ear. Large doses of quinine or salicine are well known to act in this way, but as the effect, as a rule, passes off after the use of the drug is stopped, it does not call for any special treatment.

Rushing, blowing, hissing.—In this group, which is by far the most common, I include a large number of noises which possess one or other of these characteristics. Thus, the tinnitus may be described by the patient as being like blowing off of steam, hissing of a tea-kettle, murmuring of the sea; as rustling, or even as shrill whistling, &c. When the noises are not very great they are only noticed when the patient is in quiet surroundings, and he will frequently say that he only hears them in bed.

It is very difficult to make out the exact cause of these noises, but the following consideration will serve as a guide. A disturbance of any portion of the audi-

tory apparatus which is like the disturbance produced by a real sound, will give rise to tinnitus resembling that sound. Thus, lightly brushing the membrane will produce a sense of great noise, because the brushing causes a vibration similar to that which is produced by a great noise. Syringing the ear will produce the same effect for a similar reason. Again, pressure, direct or indirect, on the nerve-endings, is not felt as such, but perceived as sound. In fact, in my opinion, the commonest cause of tinnitus is the result of such pressure; and in support of this I may call attention to the great tendency that there is to the development of tinnitus in chronic tympanic catarrh (where there is pressure exerted on the internal ear), while in chronic otorrhœa with large perforation there is far less tendency to it.

There is a peculiar form of tinnitus which is very characteristic of Ménière's disease; it consists of a sort of musical ring which becomes accentuated and intensified ("goes off *ping*" as the patient calls it) at the commencement of an attack of vertigo. This is due, I believe, to increased tension in the internal ear.

Certain diseases too—gout, and possibly rheumatism—seem to act as predisposing causes of tinnitus.

Treatment and prognosis.—The treatment of all this group must, like the preceding, be chiefly that of the condition that causes them, but I am sorry to say the results are rarely satisfactory.

Counter-irritation behind the ear will, in some cases, diminish the tinnitus and give considerable relief to the patient.

The continuous current was at one time much recommended, and in a certain number of cases its effect is greatly to diminish or entirely to remove the tinnitus. But unfortunately the improvement only remains so

long as the current is applied; hence its use has been almost abandoned.

Suction, by means of Siegle's pneumatic speculum, or a simpler but similar suction apparatus, has been found to relieve tinnitus for the time, but no greater benefit seems derivable from this than from the use of Politzer's bag.

Incision of the membrane, with or without further operative interference, such as the division of the tensor tympani tendon, has been recommended by various German authorities, but finds little or no favour in England.

From time to time various drugs have been suggested and used for their supposed direct effect on the tinnitus. The late Mr. Hinton strongly recommended a trial of chloride of ammonium internally; but the drugs most used for the purpose at the present time are, perhaps, the bromides and hydrobromic acid.

In cases of gouty diathesis, iodide of potassium and bicarbonate of potash, together with an anti-gouty regimen, will sometimes afford relief.

Professor Burckhardt-Merian found very good results from inflation with vapour of iodide of ethyl.

When tinnitus occurs in a state of chronic tympanic catarrh, there is always more probability of improving the hearing than of getting rid of the noise. Where it comes on at a very early stage in the catarrhal disease (perhaps before the patient suspects the existence of any deafness) it may yield more readily to treatment, but even then the tinnitus will often remain after the hearing power has been restored.

In some confirmed cases these noises are so distressing that they lead the patient to fear brain mischief, and to talk of suicide.

Musical.—Occasionally the tinnitus assumes a musical form, from ringing of bells up to actual tunes. Sometimes the patient will recognise it as a repeat of music heard a few hours before. I regard this as a similar form to that of the preceding group.

From the foregoing it will be seen that disease of the auditory apparatus may produce tinnitus, and this may assume one of the forms previously described. And although there is some difficulty in making a correct diagnosis, yet, should there be distinct evidence of aural disease and none of the brain itself, I think we are justified in assuming that the tinnitus is the result of the former, and in assuring our patients that there is no fear of brain mischief resulting therefrom—a fear which is almost invariably present in their mind, although they will not always own to it.

Voices.—Occasionally we meet with another form of tinnitus which may be most distressing. The patient seems to hear a voice, perhaps mocking each word he utters, or repeating sentences over and over again, frequently adding bad language, and sometimes almost driving him to despair.

I am strongly of opinion that these are always, or nearly always, cases of insanity, and in addition there is probably some aural disease. The disturbance which, in a sane person, would produce one of the ordinary forms of tinnitus, now becomes translated, as it were, into language, and so gives rise to these whimsical and distracting hallucinations.

Ear Cough.

Syncope, vomiting, giddiness, sneezing and coughing, and other phenomena of a reflex character occasionally appear to be associated with, or actually dependent upon irritation of the meatus, especially of the osseous portion. That this connection is not entirely accidental is proved by the disappearance of the phenomena in question when the source of irritation is removed, and by the fact that, to a great extent, they vary in intensity with the degree of irritation. Of these reflex symptoms, the so-called "ear-cough" is probably the most common; and some very interesting cases are on record in which, after searching vainly elsewhere for the cause of a cough, attention has at length been directed to the ear, a foreign body discovered and removed, and the cough has then quickly subsided.

Again, it is not at all unusual to find that reflex throat irritation and cough are produced by simply touching the bony meatus with a probe, &c., or on syringing out the ear.*

* An interesting account of these phenomena will be found in Roosa's *Diseases of the Ear*, 6th edit., p. 202.

APPENDIX.

FORMULÆ, ETC.

OTHÆMATOMA (p. 62).

Injection by means of subcutaneous syringe.

1. ℞ Tr. Iodi., ʒj.
Aquæ, ʒij. M.

CERUMINOUS OBSTRUCTIONS (p. 69).

Instillations for softening, all to be used warm.

2. ℞ Carbolized Almond Oil, 1 in 30.

3. ℞ Glycer., ʒiij.
Pulv. Acid. Boric., gr. x.
Aquæ, *ad* ℥j. M.

4. ℞ Liq. Morphiæ, ʒiss.
Glycer., ʒjss.
Pulv. Acid. Boric., gr. x.
Aquæ, *ad* ℥j. M.

CHRONIC LOCALISED DERMATITIS (p. 73).

Solutions for painting the denuded surface.

5. Sol. Argent. Nit., gr. xxx. to ℥j.

6. ℞ Ung. Hydrarg. Nit., ʒj.
Ol. Amygdalæ, ℥j. M.

Circumscribed Inflammation of the Meatus (p. 81).

Soothing injection.

7. ℞ Liq. Plumbi Subacet.,
Liq. Morph., āā ʒss.
Aq., *ad* ʒx. M.

One tablespoonful to a wineglass of warm water.

Ointments.

As Formula No. 6.

8. ℞ Ung. Hydrarg. Fort., ʒj.
Vaseline,
Ol. Amygdalæ, āā ʒss. M.

Diffuse Inflammation of Meatus—Acute (p. 83).

Anodyne instillations (used warm).

9. Aqueous Solution of Morphia, gr. ij. to ʒj.
10. Aqueous Solution of Atropine, gr. ½ to ʒj.
11. Aqueous Solution of Cocaine, 10 to 20 per cent.

These instillations may be conveniently prepared by crushing in a spoon, containing a few drops of warm water, one of the tabloids now so frequently employed for making hypodermic injections.

Eczema (p. 84).

Ointments.

12. ℞ Ung. Diachyli (Hebra),
Ol. Amygdalæ, āā ʒss. M.

13. ℞ Acid. Boric., ʒiij.
Glycer., ʒj.
Mix with the aid of heat and add to
White Wax, ʒss.
Vaseline, ʒv. (*York Road Hospital*).

14. ℞ Ung. Zinci Oxid., ʒj.
Glycer., ʒij. M.

15. ℞ Pulv. Calomel, ʒj.
Ung. Simplicis, ʒj. M.

Also Formula No. 6.

16. ℞ Ung. Picis,
Vaseline, āā ʒss. M.

17. ℞ Ol. Rusci, ♏viij.
Vaseline, ʒj. M.

Injections.

18. ℞ Liq. Plumbi Subacetat., ʒss.
Glycer., ʒjss.
Aq., *ad* ʒx. M.

One tablespoonful to a wine-glass of warm water.

19. ℞ Zinci Sulph., ʒss.
Glycer., ʒjss.
Aq., *ad* ʒx. M.

One tablespoonful to a wine-glass of warm water.

20. Saturated solution of Boric Acid to be used with a little hot water.

Otomycosis (p. 89).

Instillations as Formula 6.

21. ℞ Hydrarg. Perchlor., gr. j.
Sp. Vini Rect., *ad* ʒj. S.

Syphilitic Inflammation of the Meatus (p. 89), and Tympanum (p. 215).

Injection.

22. ℞ Zinci Sulph., gr. xx.
Lot. Nig., ʒx. M.

To be used with an equal proportion of warm water.

Chronic Non-Suppurative Catarrh (p. 111).

Nasal injections. To be used with ½ ounce straight glass syringe or nasal irrigator (fig. 43).

Fig. 43.—Basdon's Nasal Irrigator.

23. As much table salt as will lie (piled up) on a shilling to a wineglass of warm water.

24. ℞ Pulv. Sod. Bicarb.,
Pulv. Sod. Bibor., āā ʒiij.,
Pulv. Sacchar. Alb., ʒiij. M.
A teaspoonful to a wine-glass of warm water.

25. ℞ Pulv. Ammon. Chlor., ʒss.
Pulv. Sacchar. Alb., ʒij. M.
A teaspoonful to a wine-glass of warm water.

26. ℞ Pulv. Pot. Chlorat., ʒss.
Pulv. Sacchar. Alb., ʒij. M.
A teaspoonful to a wine-glass of warm water.

27. ℞ Glycerin. Boracis,
Sp. Vini Rect., āā ʒiss. M.
One to two teaspoonsful to a wine-glass of warm water.

28. ℞ Glycerin. Boracis.
A teaspoonful to a wine-glass of warm water.

29. ℞ Pulv. Sodæ Bicarb.
As much as will lie on a shilling in a wine-glass of warm water.

30. ℞ Glycerin. Acid. Tannici, ʒiij.
Glycer., *ad* ʒiij. M.

A teaspoonful to a wine-glass of warm water.

Paints (p. 111).

31. Glycerin. Acid. Tannici.

32. ℞ Liq. Ferri Perchlor. Fort.,
Glycer., āā ʒss. M.

33. Sol. Argent. Nit., gr. xxv. to ʒj.

34. Sol. Acid. Chrom., gr. xx. to ʒj.

Inhalations (p. 113).

Solutions for Kerr's and Basdon's chloride of ammonium inhalers.

35. Liq. Ammon. (B.P.).

36. Acid. Hydrochlor. Fort.

Ingredients for Hawksley's inhaler:

37. Ammon. Carb. (small pieces).

38. Acid. Hydrochlor. Fort., on the pumice stone.

Iodine and Ether vapour.

39. ℞ Tinct. Iodi, ʒjss.
Æther. Sulph., ʒss. M.

Forty minims with ½ pint of boiling water in an earthenware inhaler.

40. ℞ Tinct. Benzoin. Co.

One teaspoonful with ½ pint of boiling water in an earthenware inhaler.

41. Iodide of Ethyl.

Ten minims in a Politzer's bag; to be used as soon as volatilised.

Fluids introduced into the Tympanum.

42. Sol. Sodæ Bicarb., gr. x. to ʒj.

43. Sol. Potass. Iod., gr. v. to ʒj.

These solutions must be used warm.

Mixture.

44. ℞ Pot. Iod., ʒss.
Spt. Amm. Arom.,
Tr. Gentian. Co., āā ʒj. M.

A teaspoonful in a wine-glass of hot water to be taken twice a day after meals.

Chronic Suppurative Catarrh (p. 151).

Injections.

45. ℞ Liq. Plumbi Subacet., ʒss.
Glycerin. Acid. Carbol., ʒj.
Aq., ʒx. M.

46. ℞ Zinci Sulph., ʒj.
Glycerin. Acid. Carbol., ʒj.
Aq., ʒx. M.

Nos. 45 and 46.—A tablespoonful to a wine-glass of warm water.

47. Sol. (saturated) Acid. Boric., ʒij.

To be used with enough hot water as will make it pleasantly warm.

48. Boro-glyceride (Barff's).

A small teaspoonful in a claret wine-glass of warm water.

49. ℞ Glycerin. Acid. Carbol., ʒj.
Spt. Vini Rect., ʒx. M.

One or two tablespoonsful to a wine-glass of warm water.

50. Warm solutions of Carbolic Acid varying in strength from 1 in 40 to 1 in 100.

Instillations.

51. Liq. Plumbi Subacet.

To be used with an equal proportion of warm water.

52. Sol. Argent. Nit. gr. x.—xx. to ʒj.

53. ℞ Hydrarg. Perchlor. gr. ½.
Sp. Vini Rect. ʒj. S.

To be used with two or three times the quantity of warm water at first, rapidly (if the ear tolerates it) increasing the alcoholic solution until it is used pure.

54. ℞ Pulv. Acid. Bor. ʒiss.
Sp. Vini Rect. ʒiij. M.

Directions as No. 53. (Iodoform may be substituted for the Boric Acid.)

55. Peroxide of Hydrogen (10 vols.).

Two or three drops introduced from warm spoon, on a cotton-wool mop or an intra-tympanic syringe. The oxygen being set free it mechanically cleanses out any suppurating cavity. (Drs. Wilson and Dayton, New York).

Powders (to be blown in by means of a quill, see p. 154.)

56. Pulv. Cretæ Gall.

57. Pulv. Acid. Tannici.

58. Pulv. Acid. Boric.

Passed through a silk sieve.

59. Iodoform in powder.

For the absorbent treatment.

60. Absorbent cotton-wool.

61. Boric Acid Cotton-wool.

62. Salicylic Wool.

Granulations and Polypi (p. 172).

Caustics, &c.

63. P. Argent. Nit.

Fused on end of probe (p. 172).

64. Sol. Argent. Nit., ʒss—ʒi to ʒi.

Applied by means of a cotton-wool mop.

65. Acid. Chloro-Acetic.

66. Acid. Chromic.

Fused on end of probe (p. 172)

Astringents, &c.

67. Pulv. Aluminis Exsiccat.

Blown in.

68. Pulv. Plumbi Acet.

69. Pulv. Acid. Tannici.

70. Ferri Perchlor. (anhydrous).

Applied on cotton mop.

71. Saturated solution of Perchloride of Iron in Glycerine.

Applied on cotton mop.

Instillations.

As formula 53.

72. ℞ Tinct. Ferri Perchlor. ʒiii.
Spt. Vini Rect., *ad* ʒii. M.

Caries and Necrosis, Mastoiditis, &c. (p. 181).

Decalcifying injection.

73. ℞ Acid. Nit. Fort., ʒii.
Aq., ʒvii.
Misce et adde
Glycer. Acid. Carbol., ʒi. M.

An ounce to be used with twice the quantity of warm water (a bone or metal syringe must not be used).

Counter-irritants.

74. Blisters.

75. Linimentum Iodi.

76. ℞ Liq. Epispastici, ʒi.
Tr. Iodi, ʒi. M.

77. Mustard Leaves.

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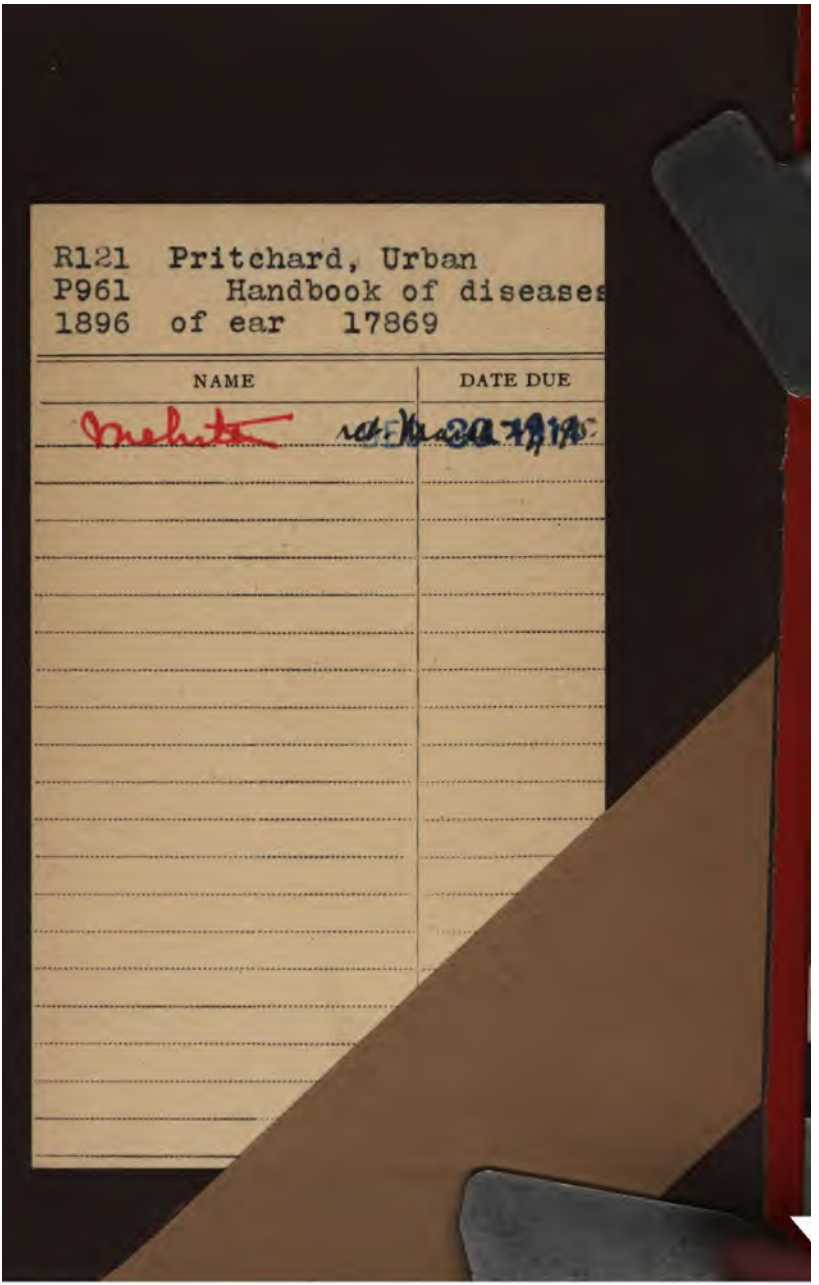

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